CDS Spreads: An Empirical Analysis of European Countries

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KAI LISA LO

Supervised by

Dr. Anurag Narayan Banerjee

Dr. Chi-Hsiou Daniel Hung

Department of Economics and Finance

Durham University Business School

Durham University

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Kai Lisa Lo

Abstract

This thesis investigates how credit default risk as reflected in credit default swap (CDS) spread is transferred in the European countries. The first part observes the default risk transfer between the sovereign debt and the domestic financial institutions of the European countries during the European sovereign debt crisis. The previous literature indicates that a "two-way feedback" effect exists between the two sectors. In this part, the bailouts by the European Financial Stability Facility are used as breakpoints to examine the changes in the default risk transfer between the two sectors. The results suggest that the two-way feedback effect does not exist after the first Greek bailout. The shocks in the financial sector transmitting to the sovereign debts become either negative or insignificant in both the short and the long runs. Subsequent to the first Greek bailout, the private-to-public risk transfer no longer exerts significant impacts, regardless of later bailouts issued to the other countries.

The second part further examines the structural regimes in the cointegration relationship of default risk between the two sectors. The empirical results indicate that the private-to-public risk transfer becomes stronger in the 'atypical' regimes, which covers the crisis periods. The approach of identifying changes in regime is robust, and the detected thresholds also confirm that it is reasonable using the EFSF bailout events as breakpoints.

The final empirical chapter focuses on the cross-country cointegration of sovereign default risk, and takes note of the role of investor sentiment in explaining the risk transfer. The findings show that investor sentiment is capable to predict regimes in the sovereign default risk in the short run. During crisis periods, the trench of the sovereign default risk is wider, but the elasticity is smaller, indicating more difficulties for the countries to close the gap of the default risk.

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Statement of Copyright

No part of this thesis has been submitted elsewhere for any other degree or qualification in this or any other university. It is all my own work unless referenced to the contrary in the text.

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Dedication

To my loving mother and father,

for their endless faith, respect and support to the lifework I have chosen.

CHAPTER ONE:

INTRODUCTION

1. Introduction

"For well-being and health, again, the homestead should be airy in summer, and sunny in winter. A homestead possessing these qualities would be longer than it is deep; and its main front would face the south."

Aristotle, *Economics*, 1.1345a, trans. Tredennick and Armstrong

The Greek philosopher and economist Aristotle wrote in his book *Economics* that for the storage of crops and of clothing and for the living of people, a stable homestead should have such qualities, '*airy in summer, and sunny in winter*' (Aristotle, *Economics*, 1.1345a, trans. Tredennick and Armstrong). For the European Union, especially for the Eurozone, the member countries are compared to the individuals who share the entire '*homestead*'. Within the financial system of the European Commission, member countries have been sharing benefits from each other to some extent, for example, a stable currency for the Eurozone. However, there are also barriers to the financial system meantime, such as different national standards for financial institutions, the exchange controls and the cost of entering the market (Dixon (1991)). When the economic environment is '*in summer*', the market is more liquid ('*airy*'); when the economic environment is '*in winter*', the guiding policies are constructive and efficient ('*sunny*' and '*its main front would face the south*'). This suggests that a healthy and stable financial system should possess such qualities.

The European sovereign debt crisis developed from early 2010 in some European countries. The unsustainable Greek sovereign debt came to a brink of imminent default in early 2010. Propagated by the European banks' significant holdings in Greek sovereign debt, and the countries having fewer monetary controls such as free exchange rate, the "Greek crisis" contagiously affected the financial sectors and sovereign debts in the other European countries. On 9 May 2010, the European

Financial Stability Facility (EFSF) issued its first bailout package worth €750 billion to ensure the financial stability of the EU countries, and more measures were taken thereafter by the governments to prevent the collapse of the financial system across Europe. Since then, concerns have been raised on the effects of the bailouts to relieve the stress of default in the sovereign and the financial sectors, and on how to improve the intervention by the governments in order to better prevent and control the crisis. These concerns become the motivation of this research.

The European Financial Stability Facility (EFSF) has been founded by 17 Eurozone countries.[1] The EFSF issued its first rescue package on 9 May 2010 for up to €750 billion to ensure the financial stability of Greece (G1). This is then followed by the rescue packages for Ireland on 25 January 2011 (I), Portugal on 15 June 2011 (P) and second bailout to Greece on 21 July 2011 (G2).[2]

The aim of Chapter 3 is to understand the ways by which default risk is transferred, if any, between the sovereign countries and the domestic financial institutions after the European Financial Stability Facility (EFSF) bailouts starting with the first Greek bailout in May 2010. This study assesses the effectiveness of a large scale government bailout which aims at preventing a financial crisis from being further propagated into a systemic risk. Previous studies have been focused on the other financial crises before 2010. Increases in sovereign default risk may reduce foreign credit to the domestic private sectors via a decline in credit supply and cause a decrease in aggregate demand of credit, since investors' perceptions to the country default risk increase (Drudi and Giordano (2000), Dooley and Verma (2001) and Tomz and Wright (2008)). On the other hand, the performance of financial sector may reflect the outlook of economic growth and influence the public finances. An increase in the default risk of a financial institution augments the probability that the institution cannot fulfil its payments to other financial counterparties, thus a systemic

[1] See Appendix 1 for details of the EFSF guarantees.
[2] See Appendix 2 for the settlements of the bailout packages for these countries.

financial crisis may arise. Acharya *et al*. (2011) use CDS spreads of the Eurozone countries for 2007-2010 and provide evidence that “two-way feedback” interdependencies exist between the sovereign and financial default risks. Furthermore, Alter and Schüler (2012) analyse the impacts of bank bailouts during the period 2007-2010 on the interdependencies between the sovereign and banking sectors, and conclude that the contagion disperses into different directions after the bank bailouts.

In order to assess the effect of the EFSF bailouts, two approaches are used to identify the breakpoints of the time-series of the credit default swap (CDS) spread. First, the study applies a commonly adopted method of observing the occurrences of historical events (see, for example, Acharya *et al*. (2011) and Alter and Schüler (2012)). Second, the breakpoints are further identified through applying the models of Gregory and Hansen (1996a and 1996b) to test cointegration with regime and trend shifts

The analysis in Chapter 3 focuses on ten European (Eurozone) countries, namely Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. The study uses daily CDS spreads to capture default risk, and analyses the risk transfer between the sovereign debts and the domestic financial institutions in each country from Nov 2007 to Oct 2012. The dynamic short- and long-term interdependencies are examined between the CDS series of sovereign debts and financial institutions, using impulse response functions (IRFs) from bivariate vector autoregressive (VAR) and bivariate vector error correction (VEC) models (see Alter and Schüler (2012)).

The findings of Chapter 3 are twofold. First, the findings show that, prior to the first Greek bailout, positive interdependencies exist between the default risk of the sovereign and financial institutions. Specifically, a shock in the sovereign CDS spread of a country is followed by increases in the CDS spread of the financial institutions in that country, and vice versa. Importantly, after the first Greek bailout, the default risk of the financial institutions loses its positive impacts on the sovereign default risk, while the strong and positive influences of the sovereign default risk on their domestic financial institutions remain. The results suggest that the bailout relieves the default risk of the financial institutions but increases the debt burdens of the government.

The strength of such effect varies across countries. The effect is most significant in countries that have high sovereign default risk such as Greece, Ireland, Italy, Portugal and Spain during the ongoing Eurozone crisis. This pattern of the results indicates that the risk transfer occurs based on the current financial situations of the governments and the domestic financial sectors of the countries. Since the sovereign default risk increases with the default risk of financial sector in the long term, the increased debt burdens of the government further weaken the private sector in the long term.

Second, for later bailouts in Greece (second bailout), Ireland and Portugal, the findings show that the default risk transfer from the financial sector to the government becomes insignificant. This indicates that the first Greek bailout was successful in stopping risk transfer from the financial to the sovereign sector, not only for Greece, but also for the other countries. The policy implication from the evidence is that a determined large bailout, such as the first Greek bailout, is indeed capable of preventing the exaggeration of risk transfer from the financial to the sovereign sector.

Following Chapter 3, Chapter 4 further examines the structural regimes in the cointegration relationship between default risk of sovereign debt and the debt of domestic financial institutions in the European countries, specifically Greece, Ireland, Italy, Portugal and Spain (GIIPS). The study endogenously identifies *typical* and *atypical* regimes where these relationships differ, and examines whether the *atypical* regimes are prelude to financial crisis. The Hansen and Seo's (2002) methodology is applied to identify the two-regime threshold cointegration in bivariate vector error-correction (VEC) models of the sovereign default risk and the default risk of domestic financial institutions for the GIIPS countries. The study defines the regime containing higher percentage of observations as the *typical* regime, and the other one as the *atypical* regime. The aim is to understand how the default risk is transferred, if any, between the sovereign and domestic financial institutions in different regimes, i.e., *typical* and *atypical* regimes. The dynamic short- and long-term interdependencies are also examined between the credit default swap (CDS) series of the sovereign debts and financial institutions in the two regimes by using impulse response functions (IRFs) from bivariate vector autoregressive (VAR) models as proposed by Alter and Schüler (2012). The empirical analysis uses daily CDS spreads to capture default risk, and examines the risk transfer between the sovereign debts and the domestic financial institutions in the GIIPS countries from June 2007 to July 2013.

Chapter 4 focuses on detecting structural breaks in the cointegration relationship between the default swap rates of the sovereign and financial sectors. The *atypical* regimes identified are mainly located around the global credit crunch period (2007-2008) and the European sovereign debt crisis (Eurozone crisis since early 2010) for the GIIPS countries. The approach of detecting regime change is robust, since the structure breaks are suggested by data rather than by subjective time-period selections. Importantly, the findings show that the responses between the sovereign and financial sectors change from one regime to the other. Previous research, Alter and Schüler (2012) for example, does not detect regime changes and find mixed results with their hypotheses.[3]

Second, in the typical regime for the countries except Greece, positive interdependencies exist between the default risk of the sovereign and financial sectors. Specifically, a shock in the sovereign daily CDS spread of a country is followed by increases in the daily CDS spread of the financial institutions in that country, and vice versa. Importantly, in the atypical regime, the impacts magnitude in positive interdependencies between the default risk of the public and financial sectors are generally much larger than that in the typical regime. This is consistent with the intuition that during the credit crunch and the Eurozone crisis periods, the financial sectors are more sensitive to the credit health of their governments. A decline in the default risk of the financial sector often leads to declines in the sovereign CDS spreads. The sensitivity of the sovereign default risk to the financial institutions' default risk is also increased.

In a sharp contrast, the interdependent relationship between the sovereign and financial sectors is different for Greece. In the typical regime, only the impacts of sovereign default risk on the default risk of the domestic financial sector are positively significant, the impacts of the other way are insignificant. In the atypical regime for Greece however, the impacts of the sovereign default risk on the default risk of the financial institutions are reduced to either zero or negative. More importantly, the default risk of the financial sector exhibits strong and negative impacts on the sovereign default risk during the credit crunch or the Eurozone crisis.

Default probabilities and recovery capability of economies vary through business cycles (Acharya *et al*. (2011)). Following Chapter 3 and Chapter 4 that detect the changes and regime shifts in the default risk transfer within individual countries, the main objective in Chapter 5 is to investigate the functional cointegrated relationship

[3] It is important to note that setting sample sub-periods by events is different from the approach identifying structural breaks.

between two series of sovereign default risk of the Eurozone countries via a functional coefficient. This functional coefficient is the difference between the investor sentiment indices in the two countries, since investor sentiment is the most important determinant of default risk (Tang and Yan (2010)).

Recent literature on the dynamics of countries' default risk and other financial variables has focused on nonlinear regime models with parametric specifications such as threshold models and others with structural breaks. In this chapter however, an alternative model is used by allowing the coefficients of linear structures to be functional following the methodology by Banerjee and Pitarakis (2013). Such models with semiparametric specifications are generally referred as functional coefficient models, which can avoid the problematic nature of the nonparametric structures such as spurious correlation (see Granger and Newbold (1974)).

The meaning of cointegration is that the linear combination of the non-stationary variables is stationary, which indicates that the variables involved in the regression do not drift apart through time, and that the cointegrating vector reveals the long-run relationship of the variables (see Engle and Granger (1987)). Furthermore, it is possible that there are shifts in the cointegrating vector, which means the long-run relationship changes, and non-linear regime models have been introduced with one or more structural breaks in cointegration (see Gregory and Hansen (1996a) and Hatemi-J (2008)). However, for the semiparametric model, the functional coefficients within the simple linear structure are able to capture more specifications such as regime shifts.

To capture the sovereign default risk, Chapter 5 uses sovereign credit default swap (CDS) spreads of ten European countries, namely Austria (AT), Belgium (BE), Denmark (DK), France (FR), Germany (DE), Italy (IT), Netherland (NL), Spain (ES), Sweden (SE), and the United Kingdom (UK) from January 2004 to September

2013. Germany CDS spreads are used as the benchmark default risk, since German financial performance has been relatively more stable than other European countries, especially than other Eurozone countries, and German government has been the main contributor of the bailouts during the global financial crisis and the recent European sovereign debt crisis. The study tests the cointegration of sovereign default risk between Germany and one of the other European countries, and the functional coefficients are regressions of the investor sentiment.

For countries' investor sentiment, three measures are applied, which are Consumer Confidence Indicator (CCI), put-call trading volume ratio (PCV) and put-call open interest ratio (PCO). Behavioural theories suggest that market optimism or pessimism or fluctuations in the economic environment could cause asset prices deviate from their intrinsic values (see Chung *et al*. (2012), De Long *et al*. (1990) and Kumar and Lee (2006)). For the application of the model, in other words, the gap of the default risk between the benchmark country and the other European country changes during the crises, and the functional coefficients of the investor sentiment measure the mispricing of the default risk of the underlying country and the adjustment speed for the country to close this gap.

The findings show that, investor sentiment predicts jumps or regimes in countries' default risk in the short-run. The long-run relationship of countries' default risk changes in different regimes. When the economic environment is stable, the gap between two countries' default risk is small, and it is easier for one country to close the gap of default risk towards the other. During crisis time, however, the trench of default risk between the countries is larger, and the elasticity of the countries' default risk is smaller, indicating more difficulties to drive the two countries' default risk back towards the normal status.

The remainder of this thesis is organised as follows. Chapter 2 provides a general review of the literature on default risk transfer and the main measures. Chapter 3 empirically examines the default risk transfer between the sovereign and financial sectors of the European countries. Following Chapter 3, Chapter 4 focuses on the regime shift in the cointegration relationship, and the thresholds of the regimes further confirm the findings in Chapter 3. Chapter 5 uses investor sentiment indices as functional coefficients to explain the cointegration relationship of the sovereign default risk of the countries. Chapter 6 concludes the main findings of the empirical chapters, and briefly proposes avenues of future investigation. The figures and the tables are at the end of each chapter.

CHAPTER TWO:

LITERATURE REVIEW

2. Literature Review

2.1. Introduction

Through this chapter, the most important literature related to the main topics of this thesis is discussed and also compared to the main findings of this research.

Section 2.2 presents a review on the literature on default risk transfer between public and financial sectors. Firstly, in Section 2.2.1, the risk transfer mechanism is classified according to the recent research on sovereign or corporate default risk. More specifically, the concept of “two-way feedback” initially introduced by Acharya *et al*. (2011) is highlighted. Section 2.2.2 explains the reasons behind the risk transfer mechanism why default risk could transfer from the public sector to the private sector or even across countries. The reasons include foreign and domestic credit imbalance, changes in global and domestic economic environments, government and corporate borrowing behaviours. In Section 2.2.3, the literature on the exposure of the financial sector to the sovereign default risk is further revealed. Following these, the measures of the default risk are displayed in Section 2.2.4, and different measures mainly used by the recent researchers are compared. Section 2.2 covers the main literature related to the empirical chapters 3 and 4, in which domestic default risk transfer between sovereign and financial sectors are investigated using different models.

The default risk transfer across countries is estimated in Chapter 5. Since the mispricing of two countries' default risk is measured by investor sentiment, Section 2.3 explains how the concept of investor sentiment is introduced to this topic, and lists the relative articles considering the importance of investor sentiment to changes in default risk. Moreover, this section also reviews the different measures of investor sentiment used for different countries.

Section 2.4 concludes the above literature and compares the main findings of this research to the literature.

2.2. Default Risk Transfer between Sovereign and Financial Sectors

2.2.1. Risk Transfer Mechanism

When a country faces financial distress, for example, high public deficit or heavy debt burdens, the sovereign default risk of this country raises and the sovereign debt devalues. In the short run, (i) for the domestic financial institutions the cost of holding the sovereign debt is higher, which changes the balance sheet of the financial institutions; (ii) for other governments that support the financially distressed country by providing bailout packages, the sovereign and financial sectors of the supporting countries also faces higher default risk for holding the devaluated sovereign debt. The financial systemic risk, which is the impacts of macroeconomic factors on banking credit risk, is procyclical to the business cycle or macroeconomic environment (Borio *et al*. (2002), Marcucci and Quagliariello (2009) and Festic, *et al*. (2011)). In the long run, sovereign debt crises are followed by reduction in foreign capital inflows as investors' awareness to the sovereign default risk increases, and the domestic credit becomes more expensive, which negatively affect the domestic economy and hence increase the default risk of the domestic financial institutions.

When a financial institution faces financial distress, the default risk of the financial institution is higher. This increases the probability that it cannot fulfil the obligations to other financial counterparties, thus the financial counterparties could face funding difficulties, and their default risk is higher. Thereafter, a systemic financial crisis might arise and hamper the whole economy, which also deteriorate public finances, thus the sovereign default risk is higher.

Acharya *et al*. (2011) document a "two-way feedback" effect between the financial sector and the sovereign sector, suggesting positive interdependences between the default risks of the two sectors. The theoretical explanation is that the government can issue a bailout via increase in taxation or dilution of existing government debt. However, such bailouts are costly, and the increased taxation could aggregate the default risk transfer from the public to the private sectors. This means domestic bailouts can drive the public-to-private risk transfer into a vicious two-way feedback loop. In this thesis the findings show that, before the first Greek bailout issued by the EFSF, the responses of sovereign default risk to the shocks in the financial sectors are positive, and vice versa.

After the government intervenes, government guarantees to the financial sector increase, thus changes in the sovereign default risk have direct impact on the perceived default risk of the financial sector. Also because the financial institutions might receive rescue capital from their governments, the financial sector is more sensitive to the credit health of their governments. Hence, the sensitivity of the financial institutions' default risk to the sovereign default risk is expected to increase. On the other hand, the default risk is transferred from the financial sector to the government sector when the government has taken over the debt burdens of the financial institutions. In the long run, a decline in the default risk of the financial sector may result in healthier economy and improve the public finances; in the short run, however, the relieved default risk of the financial institutions may lead to higher probability of government default in the future.

The findings of the thesis also observe that after the first Greek bailout, in general, while the default risk transfer from the public to the private sectors remain positive, the private-to-public risk transfer becomes either negatively negative or insignificant.

Acharya *et al*. (2011) indicate that in order to get rid of the two-way feedback loop, the government can take strategic default, which means that the government sacrifices its credit rating to maintain the economic growth and stability of the financial sector. In case of the Eurozone crisis, after a country, such as Greece, starts the application of the EFSF bailouts, the bailouts issued to maintain that country's financial sector are actually shared by other EFSF guarantees, such as Germany, or even by the whole Eurozone in the short run. The Greek government has received the bailout from the EFSF guarantees without sacrificing its own sovereign debt or increasing taxation. Thus, instead of Greece taking over the debt of the financial sector, the default risk gets transferred to other Eurozone countries. Hence, the bank-to-sovereign risk transfer in this two-way feedback loop breaks down after the EFSF bailouts issued. From Figure 3.1, it is obvious to see that the sovereign CDS spreads for all the ten Eurozone countries increase in a few days just after the first Greek bailout. This is defined as the "Greek effect".

It is expected that the outcome of the bailouts is heterogeneous among the European countries. Dieckmann and Plank (2012) report that the states of the financial system at the beginning of the financial crisis have strong explanatory power for the private-to-public risk transfer, and that an Economic and Monetary Union (EMU) member is more sensitive to the health of its pre-crisis financial system. So the private-to-public transfer was influenced in Ireland, Portugal and Spain during the first Greek bailout, but not in other countries such as Germany and France which have more stable financial system.

The result of this Greek effect is the vanishing two-way feedback effect which is not observed when Ireland and Portugal received bailouts from the EFSF later. This is because the default risk had already been priced during the first Greek bailout. This reflects the perception of market participants that these countries may also request and would be granted bailouts from the EFSF in the future. Thus the price of the default has been adjusted after the first Greek bailout.

2.2.2. Risk Transfer from Sovereign to Financial Sector

Many studies have found that sovereign debt crisis may reduce foreign credit to the domestic firms via a decline in supply and cause a decrease in aggregate demand of credit as investors' perceptions to the country default risk increase (Drudi and Giordano (2000), Dooley and Verma (2001) and Tomz and Wright (2008)). A large amount of empirical work has found that the credit patterns in the private sector change after the financial crises (Eichengreen *et al*. (2001), Desai *et al*. (2008), Pasquariello (2008) and Blalock and Simon (2009)).

Sovereign debt crises, associated with a decline in foreign credit, may hamper production in the private sector and therefore deteriorate future economic growth. Arteta and Hale (2008) investigate the role of foreign credit to emerging countries' private sector during the sovereign debt crises, and they find that the external borrowing to domestic private firms declines during debt renegotiations and afterward restructuring agreements, and this effect is more significant in the non-financial sector. In addition, only large firms which have direct access to foreign capital are considered. However, the credit to smaller firms from domestic banks is also deteriorated, since the credit from domestic banks becomes more competitive according to less foreign credit to large firms. A decline in foreign credit as the impact of sovereign debt crisis may harm the total credit to the private sector in the economy.

It is generally believed that improving a country's financing costs and sovereign risk level conduces to increasing foreign capital inflows and improving the development in the private sector through domestic credit markets. Reinhart and Rogoff (2004) assert that the foreign capital flows are influenced by sovereign default risk, which is typically indicated by sovereign CDS spreads. Recent studies have also found that sovereign default risk can capture various fundamentals of a country's debt solvency and macroeconomic environment such as debt outstanding, economic growth, etc., (Cantor and Packer (1996), Afonso (2003) and Mora (2006)).

Kim and Wu (2008) analyse the impact of sovereign credit ratings on financial market developments and foreign capital inflows in emerging markets. The results for long-term and short-term ratings are quite different. Both foreign and domestic currency long-term ratings stimulate the developments of domestic stock and banking sectors, but only foreign currency long-term ratings have positive influence on foreign capital inflows, such as FDI. On the other hand, short-term ratings in both foreign and local currency deteriorate foreign capital inflows and domestic financial markets, since the improvement in short-term ratings prevent holding more costly long-term sovereigns which represent long-term financial stability. The authors further indicate that sovereign credit ratings are not used in this study to measure the impacts of sovereign default risk on the credit risk of the banking sector, considering the ambiguous impacts on domestic credit markets.

On the other hand, Harrison and McMillan (2003) argue that although foreign direct investment brings more capital to the economy, domestic firms may be more credit constrained if foreign firms crowd local firms in the domestic credit markets. The reason is that foreign firms are more liquid, and domestic banks might invest them more as they are less risky investors. Although Harrison and McMillan's (2003) data from Ivory Coast might be an exceptive case, their research shows that when domestic credit markets are expanded, banks are encouraged to allocate credit to less risky firms when foreign direct investment increases. This means that banks take less risk when there are more foreign inflows, and they tend to expand their credit that may enlarge domestic credit markets.

Government borrowing behaviour is also an important reason that causes changes in the domestic and foreign credit inflows. Gelos *et al*. (2011) examine the factors that may influence the ability of government borrowing by developing countries from international credit markets. Except for international bonds, they also measure market access including syndicated bank loans, which is another form of sovereign borrowing in developing markets. Their empirical work covers 150 developing countries between from 1980 to 2000 with data from the World Developing Indicators (WDI) database. Their results indicate that countries with larger population and GDP tend to have more access to international credit markets. Financial vulnerability of one country is measured by average income and proportion of agriculture in GDP, and it is negatively correlated to the ability of access to international credit markets. Frequency of defaults does not significantly influences the access to international credit markets, but defaults have significantly negative impacts on market access. They also assert that larger proportion of FDI in GDP, as a measure of economic links with international credit markets, is generally related to higher sovereign access, but their empirical result that the ratio of FDI to GDP positively affects market access is not significant. They regard the ratio of FDI to GDP as the cause that affect sovereign default cost and borrowing ability, however, the changes in FDI generally follow the changes in sovereign default risk, which is the measure of government borrowing capabilities, according to the large amount of literature (Drudi and Giordano (2000), Arteta and Hale (2008) and Kim and Wu (2008)).

2.2.3. Exposure of Financial Sector to Sovereign Default Risk

Van Rijckeghem and Weder (1999) and Kaminsky and Reinhart (2000) indicate that the common creditor is the main transmission channel of spillover effects of sovereign defaults. When the sovereign default risk is higher in one country, banks have to adjust the credit expansion, recapitalise and lend less according to the lower equity. This can deteriorate the financial condition of other countries that borrow from the same creditors. From the opposite, when a sovereign has higher credit ratings, banks of that country are more willing to allocate more credits to the borrowers from other countries, and the financial position of other countries can be improved. These increased credits can make the sovereign debt even more competitive and further reduce the sovereign default risks.

The performance of banking sector may reflect the outlook of economic growth. Changes in the macroeconomic environment may turn into changes in performance of private sector, thus cause changes in banking loans and banking credit risk. Indicators of sovereign default risk, such as sovereign CDS spreads and government bond yields, have impacts on expectation of foreign investors and cause changes in foreign capital inflows and domestic credit markets, thus influence the fund sufficiency and performance of domestic private sectors. Favourable macroeconomic environment is followed by higher quality of bank loans indicated by better solvency of bank loans, less non-performing loans and lower probability of default, etc. If macroeconomic growth slows down, the increasing indebtedness of private sector could cause banking performance worse and cause banking credit risk higher.

Banking performance is one of the important factors in the risk transfer mechanism as discussed in Section 2.2.1. According to the study of Festic *et al*. (2011), the performance of the banking sector is procyclical to the economic growth, representing the overheating of the economy. When there is a slowdown in economic activity, the non-performing loans (NPL) ratio, which demonstrates the quality of bank loans, is likely to increase. In their empirical results, economy activity such as export and gross fixed capital formation (GFCF) is negatively correlated to future NPL ratio of banks. FDI in non-financial sector is positively correlated to economic activity, since a decline in FDI in non-financial sector may deteriorate the production of private sector and therefore slow down the economic growth rate, and it is likely to be positive correlated to the NPL ratio of banks. In addition, foreign direct investment in financial sector and real estate, as the opposite side, is tested to be positively related to future NPL ratio. Changes in the macroeconomic environment can be translated into changes in the private sector. Favourable macroeconomic environment conduces to decreasing the indebtedness of the private sector, which lowers the probability of default and the share of non-performing loans (NPL) to total loans in the banking sector.

Banking default risk increases when firms borrowing from banks may not fulfil their payment to the banks. General default risk, or systemic risk, refers to the risk generated from macroeconomic conditions. Insfrán Pelozo (2008) indicates that governments can make positive efforts on reducing the systemic risk faced by banks. Increasing government investments can reduce the overall risk of the whole economy and increase the probability of repayment of domestic firms, and thus the problem of credit crunch can be relieved. Credit crunch arises especially when foreign credit investments decrease sharply and domestic financial system cannot supply sufficient funds to domestic investors or firms. On the other hand, when the government has large debt burdens and high default risk, its capability is low to reduce market failures in providing investments in the financial markets and improve solvency for the financial sector.

Recent banking studies research on the relation between banking credit risk and the business cycle for purpose of analysing macro financial stability, and banks' portfolio riskiness is procyclical. Marcucci and Quagliariello (2009) examine the asymmetric behaviour of procyclical banking credit risk over different phases of the business cycle. Festic *et al*. (2011) assume that banks' credit expansion and the NPL ratio are procyclical within a business cycle. Banks tend to have credit expansion and have lower capital ratio during economic upturns. Banks take precautionary measures when they expect the possibility of write-offs and provisions and have higher capital ratio.

Risk is accumulated during economic upturns but realised during downturns (Borio *et al*. (2002)). The macroeconomic environment can be described by GDP growth, exports, asset prices, foreign investment, and unemployment rate, etc. Economic booms are accompanied by rapid credit expansion, excessive capital inflows and high levels of investment and export growth, and credit risk is accumulated to be higher during upturns. From the demand side, firms raise credit demand from the banking sector to enlarge production, and households want to borrow more to purchase more goods. From the supply side, banks expand more credits to the firms and households. But during economic recessions, banks tend to prepare more capital for the possibility of loan defaults by the private sector. For this reason, the impacts of macroeconomic factors on banks' credit expansion and loan performance are procyclical (Kiss *et al*. (2006) and Sirtaine and Skamnelos (2007)). Domestic banks may face the liquidity problems when there is a sudden withdrawal of deposits. Economic recessions can be caused by sudden decrease in foreign capital inflows according to changes in domestic interest rates, financial market balance or investors' confidence. If domestic banks borrow in foreign currency and lend in local currency, a sudden depreciation may lead to higher debt burdens for domestic firms that can increase the credit risk and deteriorate the performance of the banking sector (Borio *et al*. (2002)).

Maltritz (2010) investigates the interrelation between banking crises and country defaults using the case of Hungary. His research indicates that the banking crises arise because of the shortage of the government funds for debt service payments and the high outstanding debt burdens, rather than problems in the domestic banks. The problems in the domestic banks only influence the crises marginally, since compared to the debt service payments for the whole economy, and the payments for bailing-out the banking sector are unconsidered.

In the thesis, the interrelation between country default risk and banking default risk is analysed for the European countries. The reason of the contagious effect during the European sovereign debt crisis may not be from the domestic country, but spilled over from the country that has severe debt burdens such as Greece. The research of Ismailescu and Kazemi (2010) also convince this reason. They analyse the spillover effects of credit rating announcements, and asserts that the level of spillover effect of positive announcements is influenced by non-event countries' credit ratings, and the level of spillover effect of negative announcements is influenced by the event country's credit rating. Moreover, Durbin and Ng (2005) investigate the question of "sovereign ceiling", which considers whether government bonds are creditworthy than firm bonds. The results show that several firms' bonds are traded at lower spreads than government bonds, indicating that investors do not apply the "sovereign ceiling" all the time. Those firms that do not apply the "sovereign ceiling" tend to generate substantial export earnings or have close relationships to foreign firms or to the government. Corporate risk is more correlated to government risk in markets that have higher overall default risk. Their research analyses how government risk affects the firms' asset pricing in emerging markets. Firms of the private sector constitute a major portion of economic growth, thus it is extremely necessary to research on the factors that drive firms' risk, such as financial distress or government default risk. Recently, Ejsing and Lemke (2011) analyse both sovereign and bank CDS premia after the bailout packages were announced by the euro area governments in 2008. They get to the conclusion that government CDS spreads increased and bank CDS spreads decreased, indicating that the bailout packages relieved the banking crises for the moment but increased the government debt burdens.

2.2.4. Measures of Default Risk

Studies have shown that sovereign CDS spreads can measure foreign investors' risk preference and domestic economic environment. According to Ismailescu and

Kazemi (2010), investors can make decisions according to the same public information that would lead to the changes in CDS spreads prior to a rating announcement. The authors examine the response of sovereign CDS spreads to the announcements of credit ratings using data from emerging countries, and an asymmetric response is found. Announcements of improvement in credit ratings contribute more information than announcements of deterioration, and this indicates the anticipation effect of negative announcements that causes CDS market prior to credit ratings. Investors may use adjustments in sovereign CDS spreads to estimate the rating announcements, especially the negative announcements.

Hull *et al*. (2004) analyse the relationship between the CDS market and rating events. Their empirical research indicates that CDS spread changes conditional on rating events, and downgrade announcement and negative outlooks do not have helpful information. On the other hand, both changes and levels of CDS spread contain significant information in estimating the probability of negative rating events. They also reach the less significant results on positive rating announcements, and the fact is likely to accounts for the results that positive rating events are far fewer than negative rating events.

Banks' CDS spreads may indicate banking credit risk from three risk sources including idiosyncratic risk, systematic risk and liquidity risk. Düllmann and Sosinska (2007) explore the CDS spreads of the German banks, and their empirical analysis exhibits significant results that banks' CDS spreads can reflect the three sources of banking credit risk. Particularly, systematic risk accounts for higher percentage of the explained variation of CDS spreads than the other two risk sources. The market index and the swap spread[4] are considered to measure systematic risk. Systematic risk, or market risk, is the risk associated with aggregate market returns. Higher market returns are generally associated with declining risk premia, and

[4] The swap spread is a proxy for the credit risk-free interest rate which is measured by the difference between the European interest rate swap rate and German government zero-bond rate.

reflect investors' higher expectations of economic environment and lower levels of risk aversion. Thus smaller CDS spreads indicate lower levels of systematic risk.

To conclude, CDS spreads are preferred by most researchers, and in this thesis, series of CDS spreads of sovereign countries and financial institutions are applied as well, in order to capture the default risk of the public and financial sectors.

2.3. Investor Sentiment

Following the above literature, it is found that default probabilities and recovery capability of economies vary through business cycles (Acharya *et al*. (2011)). Changes in sovereign default risk of countries could have contagious influence on each other via changing the supply and demand of foreign credit, since investors' perceptions are responsive to market instability (Drudi and Giordano (2000), Dooley and Verma (2001) and Tomz and Wright (2008)). It is essential to investigate the interactions of countries' default risk so that to foresee the risk transmission cross-country and to prevent further deterioration.

The main objective in the final empirical chapter is to investigate the functional cointegrated relationship between two series of sovereign default risk of the Eurozone countries via a functional coefficient, which is the investor sentiment in the two countries, since investor sentiment is the most important determinant of default risk (Tang and Yan (2010)).

Previous research has employed the composite index of investor sentiment, the Conference Board Consumer Confidence Index or the University of Michigan's Consumer Sentiment Index when analysing the U.S. market (see Baker and Wurgler (2006), Chung *et al*. (2012), Ho and Hung (2012), Mclean and Zhao (2012) and Tang and Yan (2010)), however, such indices are not available for the European market.

Ho and Hung (2012) apply Consumer Confidence Indicator (CCI) developed by the European Commission for the European countries, and the final empirical chapter of this thesis also uses CCI as one of the sentiment measures. The CCI is based on harmonised surveys for different sectors of the countries in the European Union (EU).

For the high frequency data, the put-call trading volume ratio (PCV) and the put-call open interest ratio (PCO) are also used, which are introduced in the work of Wang et al. (2006). PCV is the ratio of trading volume of put options to call options, and PCO is the ratio of open interest of put to call options. Since market participants buy put options when they are pessimistic of the market, the PCV or the PCV ratio goes up indicating higher mispricing of the assets.

Recent literature on the dynamics of countries' default risk and other financial variables has focused on nonlinear regime models with parametric specifications such as threshold models and others with structural breaks. This study however, uses an alternative model by allowing the coefficients of linear structures to be functional following the methodology by Banerjee and Pitarakis (2013). Such models with semiparametric specifications are generally referred as functional coefficient models, which can avoid the problematic nature of the nonparametric structures such as spurious correlation (see Granger and Newbold (1974)).

For countries' investor sentiment, the study applies three measures, which are Consumer Confidence Indicator (CCI), put-call trading volume ratio (PCV) and put-call open interest ratio (PCO). Behavioural theories suggest that market optimism or pessimism or fluctuations in the economic environment could make asset prices deviate from their intrinsic values (see Chung *et al* (2012), De Long *et al* (1990) and Kumar and Lee (2006)). Recent financial economists have indicated that investor sentiment is an important factor which affects the returns and volatility of assets, especially for the stock market. Previous research has shown that the mispricing is corrected when the economic fundamental are revealed and is reflected in sentiment directly. This suggests the predictive power of investor sentiment for pricing correction.

When recent European sovereign debt crisis develops, more and more attention has been concentrated at the pricing correction power on credit spreads, as credit default swap spreads measure the default risk of an entity. Tang and Yan (2010) have concluded through empirical analysis on corporate CDS spreads that investor sentiment is the most important determinant of default risk.

The investigation in the final empirical chapter contributes to the application of investor sentiment in analysing the pricing correction of sovereign default risk. More specifically, for the application of the model, the gap of the default risk between the benchmark country and the other European country changes during the crises, and the functional coefficients of investor sentiment measure the mispricing of the default risk of the underlying country and the adjustment speed for the country to close this gap. The results show that, during crisis periods, the pricing correction power of the sovereign default risk is weaker for most countries towards a relatively stable level.

2.4. Conclusion

Overall, this chapter reviews the literature looking at the link between the countries' default risk and the default risk of the domestic financial sector, and on the reasons why countries' default risk is contagious across countries.

Firstly, the literature developed on default risk transfer between public and financial sectors has been reviewed. The risk transfer mechanism is explained, and more specifically, the concept of “two-way feedback” is highlighted. The chapter further explains the reasons behind the risk transfer mechanism why default risk could transfer between the public and private sectors or even across countries. The reasons include foreign and domestic credit imbalance, changes in global and domestic economic environments, government and corporate borrowing behaviours. The chapter also reviews the literature on applying the concept of investor sentiment in this area. Moreover, different measures of default risk and investor sentiment are introduced.

Recent literature has constructed models that are able to capture the risk transfer mechanism, most important, the research by Acharya *et al*. (2011) defines the concept of feedback effect, which indicates that default risk is able to transfer among sector. However, there are limitations to these researches. One is that the data periods used by the literature are before the ongoing European sovereign debt crisis (Eurozone crisis). Due to the specific characters of the Eurozone, patterns observed from the previous crises in other countries are not applicable anymore, suggesting that the Eurozone countries need different rescue policies to survive the Eurozone crisis.

According to this, the main objective of this thesis is to detect the pattern of risk transfer among sectors. Is there any risk transfer among sectors? Furthermore, are there any changes in the pattern of risk transfer after certain bailout is issued? In Chapter 3 and 4, these questions are explored using different methodologies, and briefly, the main findings confirm theses questions, and also find different pattern of risk transfer compared to the previous literature.

CHAPTER THREE:

THE GREEK EFFECT: DEFAULT RISK TRANSFER BETWEEN EUROZONE SOVEREIGN AND FINANCIAL SECTORS

3. The Greek Effect: Default Risk Transfer between Eurozone Sovereign and Financial Sectors

3.1. Introduction

The aim of this study is to understand the ways by which default risk is transferred, if any, between the sovereign countries and the domestic financial institutions after the European Financial Stability Facility (EFSF) bailouts starting with the first Greek bailout in May 2010. The study assesses the effectiveness of a large scale government bailout which aims at preventing a financial crisis from being further propagated into a systemic risk.

The unsustainable Greek sovereign debt came to a brink of imminent default in early 2010. Propagated by the Eurozone banks' significant holdings in Greek sovereign debt, the "Greek crisis" contagiously affected the financial sectors and sovereign debts in the other Eurozone countries. Subsequently complicated by the public debt crises of Ireland, Portugal and Spain[5], the "Greek crisis" was rolled into a fully-fledged European sovereign debt crisis (Eurozone crisis). The unprecedented Eurozone crisis has caused significant concerns to the policymakers. A new institution called the European Financial Stability Facility (EFSF) has since been founded by 17 Eurozone countries.[6] The EFSF issued its first rescue package on 9 May 2010 for up to €750 billion to ensure the financial stability of Greece (G1). This is then followed by the rescue packages for Ireland on 25 January 2011 (I), Portugal on 15 June 2011 (P) and second bailout to Greece on 21 July 2011 (G2).[7]

[5] The sovereign debt crisis in Ireland was triggered by Irish previous banking crisis in 2008, that the six state guaranteed banks financed a property bubble. The Portugal crisis was caused by the increased public expenses, such as high management cost and increased bonuses and wages to the government officers. Spain also had a housing bubble, and as the housing bubble burst out, the banking crisis transferred to the sovereign debt.

[6] See Appendix 1 for details of the EFSF guarantees.

[7] See Appendix 2 for the settlements of the bailout packages for these countries.

In order to assess the effect of the EFSF bailouts, the study uses two approaches to identify the breakpoints of the time-series of the credit default swap (CDS) spread. First, a commonly adopted method of observing the occurrences of historical events is applied (see, for example, Acharya *et al*. (2011) and Alter and Schüler (2012)). The breakpoints are identified by applying the models of Gregory and Hansen (1996a and 1996b) to test cointegration with regime and trend shifts.

The analysis focuses on ten Eurozone countries including Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. The study uses daily CDS spreads to capture default risk, and analyses the risk transfer between the sovereign debts and the domestic financial institutions in each country from Nov 2007 to Oct 2012. The study examines the dynamic short- and long-term interdependencies between the CDS series of sovereign debts and financial institutions, using impulse response functions (IRFs) from bivariate vector autoregressive (VAR) and bivariate vector error correction (VEC) models (see Alter and Schüler (2012)).

The contribution of this study is twofold. First, we use the four bailouts by the EFSF as the breakpoints for all the countries and investigate the changes in the default risk transfer in the pre- and post-bailout periods. The findings show that, prior to the first Greek bailout (G1), positive interdependencies exist between the default risk of the sovereign and financial institutions. Specifically, a shock in the sovereign CDS spread of a country is followed by increases in the CDS spread of the financial institutions in that country, and vice versa. Importantly, after G1, the default risk of the financial institutions loses its positive impacts on the sovereign default risk, while the strong and positive influences of the sovereign default risk on their domestic financial institutions remain. The results suggest that since the G1 bailout is supported by the EFSF guarantee countries, the bank-to-sovereign risk transfer in the two-way feedback breaks down, and the sovereign risk is transferred to the other bailout guarantees.

The strength of such effect varies across countries. The effect is most significant in countries that have high sovereign default risk such as Greece, Ireland, Italy, Portugal and Spain (GIIPS). This pattern of the results indicates that the risk transfer occurs based on the current financial situations of the governments and the domestic financial sectors of the countries. Since the GIIPS countries are the main beneficiaries of the bailouts, the bank-to-sovereign risk transfer in the GIIPS countries breaks down after the bailouts, while the other bailout guarantees are still in the two-way feedback loop. And we call this the "Greek effect".

Second, for later bailouts in Greece (second bailout), Ireland and Portugal, the findings show that the default risk transfer from the financial sector to the government becomes insignificant. This indicates that the first Greek bailout was successful in stopping risk transfer from the financial to the sovereign sector, not only for Greece, but also for the other countries. The policy implication from the evidence is that a determined large bailout, such as the first Greek bailout, is indeed capable of preventing the exaggeration of risk transfer from the financial to the sovereign sector.

Previous studies have been focused on the other financial crises before 2010. Increases in sovereign default risk may reduce foreign credit to the domestic private sectors via a decline in credit supply and cause a decrease in aggregate demand of credit, since investors' perceptions to the country default risk increase (Drudi and Giordano (2000), Dooley and Verma (2001) and Tomz and Wright (2008)). Kim and Wu (2008) analyse the impact of sovereign credit ratings on financial market developments, and show that the rating events stimulate the developments of domestic stock markets and banking sectors. On the other hand, the performance of financial sector may reflect the outlook of economic growth and influence the public finances. An increase in the default risk of a financial institution augments the probability that the institution cannot fulfil its payments to other financial counterparties, thus a systemic financial crisis may arises. Acharya *et al*. (2011) use CDS spreads of the Eurozone countries for 2007-2010 and provide evidence that "two-way feedback" interdependencies exist between the sovereign and financial default risks. Furthermore, Alter and Schüler (2012) analyse the impacts of bank bailouts during the period 2007-2010 on the interdependencies between the sovereign and banking sectors, and conclude that the contagion disperses into different directions after the bank bailouts.

The remaining part of this chapter is organised as follows. Section 3.2 explains the mechanism of risk transfer between the sovereign and banking sectors. Section 3.3 is the data description. Section 3.4 explains the estimation methodology. Section 3.5 analyses the results of the Greek first bailout by the EFSF, and compares the results to the later bailouts in Greece (second bailout), Ireland and Portugal. Section 3.6 concludes.

3.2. Mechanism of Risk Transfer

When a country faces financial distress, for example, high public deficit or heavy debt burdens, the sovereign default risk of this country raises and the sovereign debt devalues. In the short run, (i) for the domestic financial institutions the cost of holding the sovereign debt is higher, which changes the balance sheet of the financial institutions; (ii) for other governments that support the financially distressed country by providing bailout packages, the sovereign and financial sectors of the supporting countries also faces higher default risk for holding the devaluated sovereign debt. The financial systemic risk, which is the impacts of macroeconomic factors on banking credit risk, is procyclical to the business cycle or macroeconomic environment (Borio *et al*. (2002), Marcucci and Quagliariello (2009) and Festic, *et al*.

(2011)). In the long run, sovereign debt crises are followed by reduction in foreign capital inflows as investors' awareness to the sovereign default risk increases, and the domestic credit becomes more expensive, which negatively affect the domestic economy and hence increase the default risk of the domestic financial institutions.

When a financial institution faces financial distress, the default risk of the financial institution is higher. This increases the probability that it cannot fulfil the obligations to other financial counterparties, thus the financial counterparties could face funding difficulties, and their default risk is higher. Thereafter, a systemic financial crisis might arise and hamper the whole economy, which also deteriorate public finances, thus the sovereign default risk is higher.

Acharya *et al*. (2011) document a "two-way feedback" effect between the financial sector and the sovereign sector, suggesting positive interdependences between the default risks of the two sectors. The theoretical explanation is that the government can issue a bailout via increase in taxation or dilution of existing government debt. However, such bailout is costly, and the increased taxation could aggregate the default risk transfer from the public to the private sectors. This means domestic bailouts can drive the public-to-private risk transfer into a vicious two-way feedback loop. In the research the findings show that, before the first Greek bailout issued by the EFSF, the responses of sovereign default risk to the shocks in the financial sectors are positive, and vice versa.

After the government intervenes, government guarantees to the financial sector increase, thus changes in the sovereign default risk have direct impact on the perceived default risk of the financial sector. Also because the financial institutions might receive rescue capital from their governments, the financial sector is more sensitive to the credit health of their governments. Hence, the sensitivity of the financial institutions' default risk to the sovereign default risk is expected to increase.

On the other hand, the default risk is transferred from the financial sector to the government sector when the government has taken over the debt burdens of the financial institutions. In the long run, a decline in the default risk of the financial sector may result in healthier economy and improve the public finances; in the short run, however, the relieved default risk of the financial institutions may lead to higher probability of government default in the future.

The research also observes that after the first Greek bailout, in general, while the default risk transfer from the public to the private sectors remain positive, the private-to-public risk transfer becomes either negatively negative or insignificant.

Acharya *et al*. (2011) indicate that in order to get rid of the two-way feedback loop, the government can take strategic default, which means that the government sacrifices its credit rating to maintain the economic growth and stability of the financial sector. In case of the Eurozone crisis, after a country, such as Greece, starts the application of the EFSF bailouts, the bailouts issued to maintain that country's financial sector are actually shared by other EFSF guarantees, such as Germany, or even by the whole Eurozone in the short run. The Greek government has received the bailout from the EFSF guarantees without sacrificing its own sovereign debt or increasing taxation. Thus, instead of Greece taking over the debt of the financial sector, the default risk gets transferred to other Eurozone countries. Hence, the bank-to-sovereign risk transfer in this two-way feedback loop breaks down after the EFSF bailouts issued. From Figure 3.1, it is obvious to see that the sovereign CDS spreads for all the ten Eurozone countries increase in a few days just after the first Greek bailout. This is defined as the "Greek effect".

It is expected that the outcome of the bailouts is heterogeneous among the European countries. Dieckmann and Plank (2012) report that the states of the financial system at the beginning of the financial crisis have strong explanatory power for the private-to-public risk transfer, and that an Economic and Monetary Union (EMU) member is more sensitive to the health of its pre-crisis financial system. So the private-to-public transfer was influenced in Ireland, Portugal and Spain during the first Greek bailout, but not in other countries such as Germany and France which have more stable financial system.

The result of this Greek effect is the vanishing two-way feedback effect which is not observed when Ireland and Portugal received bailouts from the EFSF later. This is because the default risk had already been priced during the first Greek bailout. This reflects the perception of market participants that these countries may also request and would be granted bailouts from the EFSF in the future. Thus the price of the default has been adjusted after the first Greek bailout.

3.3. Data Description

The analysis uses CDS spreads to capture credit default risk of an institution, or the government. Studies have shown that CDS spreads can measure investors' risk preference. According to Hull *et al*. (2004), both changes and levels of CDS spread contain significant information in estimating the probability of rating events, but CDS spread changes conditional on rating events, and downgrade announcements and negative outlooks do not have helpful information. Ismailescu and Kazemi (2010) analyse the relationship between the sovereign CDS spreads and the sovereign credit ratings, and show that investors can make decisions according to the same public information that would lead to the changes in CDS spreads prior to a rating announcement. Düllmann and Sosinska (2007) analyse the CDS spreads of banks, and document that banks' CDS spreads indicate banking credit risk from three risk sources including idiosyncratic risk, systematic risk and liquidity risk.

The daily data of CDS spreads is collected from Thomson Reuters CDS. The selection of financial institution and sovereign CDS series was restricted by data availability. 10 Eurozone countries are analysed, including Austria (AT), Belgium (BE), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), and Spain (ES) (see Panel A of Appendix 3)[8], together with their domestic financial institutions (40 financial institutions in total, see Panel B of Appendix 3). The CDS series of the financial institutions are chosen according to the Standard Industrial Classification (SIC) code of the institutions (major groups 60-67, including Finance, Insurance, and Real Estates), respectively. Most of the financial sector constituents of the iTraxx Europe index (13 out of 25) are covered by the data set, which indicates that the financial institutions chosen are representative of the financial sectors of these Eurozone countries.

The study uses five-year CDS, since it is the largest and the most liquid constituent of the CDS markets. The restructuring type of the sovereign CDS series is Complete Restructuring (CR), as it is the only restructuring clause applied by the sovereign CDS series. The restructuring type of the financial institutions is "Modified-Modified" (MM) Restructuring. The former restructuring clause, Modified Restructuring (MR), had been too severe in its limitation of 60-month deliverable obligations, and the MM restructuring clause has been introduced and applied by the European market participants since 2003.

The data set used to test the first Greek bailout starts from 13 November 2007 until 17 February 2012. The Greek CDS series stops on 17 February 2012, after Greek debt restructuring triggered approximately \$3.2bn CDS credit protection payout on Greek sovereign debt in early March 2012. The CDS series for other countries extends until 08 October 2012.

[8]We intend to cover the 17 Eurozone guarantees of the EFSF, from which Cyprus, Estonia, Slovakia, and Slovenia are excluded because of no data of corporate CDS series available, Luxemburg is excluded as no data of sovereign CDS series provided, Malta is excluded as neither corporate nor sovereign CDS series available, and Finland is excluded because of no CDS series data of financial institutions available.

The study investigates the interdependence of the sovereign and the financial institution CDS series in two sub-periods. The first stage starts from 13 November 2007 until 7 May 2010 and contains 649 observations for each CDS series. On 9 May 2010, the European Financial Stability Facility (EFSF) set out the first bailout package to Greece worth up to €750 billion aimed at rescuing financial stability across the European countries. The second stage starts from 10 May 2010 after the first rescue package set out, and it ends on 17 February 2012 before the second bailout package worth €130 billion approved by the Eurozone countries together with the IMF and the Institute of International Finance.

The dataset has been separated into two groups. One group includes the countries that have requested for the bailout funding from the EFSF or have been facing severe default risk, i.e., Greece, Ireland, Italy, Portugal and Spain (GIIPS). The other group is constituted of the other guarantees of the EFSF that have contributed the most to the bailouts, i.e., Austria, Belgium, France, Germany and Netherlands (non-GIIPS).

Figure 3.1 shows the sovereign CDS spreads for each of the ten countries in the sample. The bailout periods for Greece (first (G1) and second (G2) bailouts), Ireland (I) and Portugal (P) are displayed. Before February 2010, the sovereign CDS spreads of all the countries remain low and stable. The sovereign CDS spreads of the GIIPS countries continue to increase after the first Greek bailout (G1). But since the second Greek bailout (G2), except the Greek sovereign CDS spreads remaining high, the sovereign CDS spreads of the other four countries have started to come down.

[Insert Figure 3.1]

Panel A, B and C of Figure 3.2 visually display the co-movement of the sovereign CDS spreads and the CDS spreads of domestic financial institutions in Greece, Ireland and Portugal, respectively. The CDS spreads of the institutions increase after the Greek first bailout (G1) reaching the peak at the second Greek bailout (G2).

[Insert Figure 3.2]

Appendix 4 shows the summary statistics of the CDS spreads of the sovereign debts and the financial institutions for the ten countries. In general, the sovereign CDS spreads of the GIIPS countries are much higher than the sovereign CDS spreads of non-GIIPS countries, which indicates that the GIIPS countries have been suffering severe sovereign default risk during the Eurozone crisis.

3.4. Estimation Methodology

This part first explains the method by Gregory and Hansen (1996a and 1996b), which is used in the research to select break points for the whole dataset. Next the study constructs bivariate vector autoregressive (VAR) and bivariate vector error correction (VEC) models as proposed by Alter and Schüler (2011) in order to examine the dynamic short- and long-run interdependency of the sovereign and financial institutions' CDS series. Except for the cointegration analysis, impulse response functions (IRFs) are also included to capture the dynamic relationship between the CDS series.

3.4.1. Determining Break Points

The study carries out the empirical analysis in two sub-periods: before and after the EFSF bailouts. Prior to the VAR and VEC model analyses, the study applies the models of Gregory and Hansen (1996a and 1996b) to check the rationality to set sub-periods according to certain bailouts.

The model by Gregory and Hansen (1996a and 1996b) treats the timing of a structural change as unknown. The structural change would be reflected in changes in the intercept and /or the slope coefficients, and a dummy variable is defined to model the structural change:

$$\varphi_{t\tau} = \begin{cases} 0 & if \quad t \le [n\,\tau], \\ 1 & if \quad t > [n\,\tau], \end{cases}$$

where the unknown parameter $\tau \in (0,1)$ denotes the timing of the break point, and [ ] denotes integer part. Structural change can take several forms where the intercept, slope, and/or trend coefficients change at unknown timing:

Model 1: Level shift (C)

$$cds_{Fi,t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t, \qquad t = 1, \ldots, n. \tag{3.1}$$

Model 2: Level shift with trend (C/T)

$$cds_{Fi,t} = \mu_1 + \mu_2 \varphi_{t\tau} + \beta t + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t, \qquad t = 1, \ldots, n. \tag{3.2}$$

Model 3: Regime shift (C/S)

$$cds_{Fi,t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t} \varphi_{t\tau} + e_t, \qquad t = 1, \ldots, n. \tag{3.3}$$

Model 4: Regime and trend shift (C/S/T)

$$cds_{Fi,t} = \mu_1 + \mu_2 \varphi_{t\tau} + \beta_1 t + \beta_2 t \varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t} \varphi_{t\tau} + e_t, \quad t = 1, \ldots, n. \tag{3.4}$$

where $cds_{j,t}$ with $j \in (Sov, Fi)$ is CDS spreads in log-levels of institution j at day t, i.e.

the logarithmised CDS spreads of the government (in short '*Sov*') or a financial institution (in short '*Fi*'). The null hypothesis is that there is no cointegration between the two variables in the presence of a regime shift at unknown timing. The *ADF*-, Z_α-, and Z_t-type tests are taken to test the null hypothesis, and the critical values are calculated by simulation methods.

3.4.2. VAR and VEC Models

Prior to estimation of the VAR and VEC models, the study tests the unit roots of the log-level CDS spreads and the first differences of the log levels using the augmented Dickey-Fuller (ADF) tests with 12 lags included for the two sub-samples, respectively (see Appendix 5). Both trends and intercepts are included when the ADF tests are carried out for the log-level CDS spreads, but only intercepts are included when testing the first difference of the log-level variables, since a trend in levels turns into a constant in first differences. If the variable in log-levels is $I(1)$, i.e., reject null hypothesis of unit roots in first differences and cannot reject in log-levels, the cointegration of the VEC framework is carried out for the variable; if the variable in log-levels is stationary $I(0)$, i.e., reject null hypothesis of unit roots in log-levels, a VAR model for the log-level variable is applied, as the variable cannot be cointegrated with another stationary or non-stationary variable.

To test the cointegration of the $I(1)$ variables for each bivariate model, Johansen's trace tests are applied except for the ADF tests (see Appendix 6). If the variable in log-levels can be cointegrated, i.e., reject maximum rank at 0 or 1, the study proceeds to estimate the VEC. Moreover, the optimal lag order p in the VAR and the VEC models is determined by, on the one hand, minimising the common information criteria in the underlying VAR model of the log-levels, and on the other hand considering autocorrelations of the residuals and joint tests of reducing unnecessary lags in the models. The VEC model is estimated via Johansen's maximum likelihood method and the VAR model via ordinary least squares.

After determination of the sub-periods according to the breakpoints found and the actual bailout events, the study estimates the following VAR and VEC models with a sovereign CDS spreads (in short '*Sov*') and a domestic financial institution's CDS spreads (in short '*Fi*'):

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t \,, \tag{3.5}$$

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} \left(\beta_{Sov} cds_{Sov,t-1} + \beta_{Fi} cds_{Fi,t-1} + \beta_0 \right)$$

$$+ \sum_{i=1}^{p-1} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t \,, \tag{3.6}$$

where $cds_{j,t}$ with $j \in (Sov, Fi)$ is the CDS spread in log-level of institution j at day t, i.e. the logarithmised CDS spread of the government or the financial institution. $\Delta cds_{j,t}$ refers to the first difference of $cds_{j,t}$. v is a vector of constants. After the VEC model estimated, short-run Granger causality tests are taken in order to check the general direction of the short-run risk transfer (see Appendix 7). From the results of the Granger causality tests, there is no significant pattern for the GIIPS and the non-GIIPS countries. For example, in the case of Austria, the private-to-public and public-to-private causality results are all significant before and after the first Greek bailout. Thus, it is necessary to take impulse response functions (IRFs) to see the responses to the shocks in each lagged term.

Noted that a VEC model with (p-1) lags can be represented as a VAR structure with p lags, this study uses impulse response functions (IRFs) of VAR models using CDS spreads in log-levels. Impulse response functions (IRFs) are used to depict the impacts of one-time shock to a variable within one standard deviation not only on itself but also on other endogenous variables of current and future periods; in other words, IRFs trace the reactions of endogenous variables according to the changes of other exogenous variables in different periods. The variables generated (innovations or impulses) are correlated according to the above correlations of residuals for the bivariate VAR models, and these innovations ought to be orthogonalised.

3.5. Empirical Findings

3.5.1. Classification of Sub-Periods of EFSF Bailouts

In this section, the tests (as described in section 3.4.1) by Gregory and Hansen (1996a and 1996b) are applied to detect structural breaks in the log-CDS series. For exposition purpose, the log-CDS series of *gr* (Greek sovereign debt) and *aca* (Alpha Bank) are used, and Table 3.1 shows the results. The results in the Z_t and Z_α tests using the C/S/T model (significant at 5% level) suggest that there is a breakpoint on 12 May 2010, and the result in the *ADF* test using the C/S model (significant at 10% level) indicates that the breakpoint is on 21 September 2011. The date of the first breakpoint is very close to the first Greek bailout issued on 9 May 2010.

[Insert Table 3.1]

Similarly breakpoints are also examined in the CDS series of Ireland, Portugal, Spain, and Italy using the Gregory and Hansen (1996a and 1996b) models. Table 3.2 shows the summary of the earliest and latest breakpoints for the GIIPS countries. The findings show that these significant breakpoints are close to the four bailouts (G1, I, P G2) issued by the EFSF, indicating that the bailouts change the pattern of interdependencies of the default risk between the sovereign and financial sectors, and it is proper to set sub-periods according to the timing of the EFSF bailouts.

[Insert Table 3.2]

Given that the actual bailout dates are close to the breakpoints of the CDS series, for the time period of the first Greek bailout, the G1 issue date (9 May 2010) is used as the breakpoint for the ten countries (GIIPS and non-GIIPS countries). For later EFSF bailouts (I, P and G2), sub-periods are set for Greece, Ireland and Portugal according to the country's application and/or bailout dates, respectively.

Five sub-periods are set for Greece (see Appendix 8). The first period, pre-bailout period, ends on 9 May 2010, which is the settlement date of the first tranche of the bailout worth €20 billion. The official request for rescue from the Greek government was issued on 23 April 2010, and a three-year financial aid programme (loan commitments) worth €110 billion was agreed on 2 May 2010 by the European Union (EU), European Central Bank (ECB), and International Monetary Fund (IMF).[9] As the application period before the first bailout is too short, the study includes this period into the pre-bailout period. The first bailout period starts from 10 May 2010 and ends on 21 July 2011, which is the approval date of the second rescue package agreed by the 17 EFSF guarantees. The application period of second bailout ends on the date of the final agreement by the EFSF (20 February 2012), and the second bailout period is between the date of the final agreement and the settlement of the last tranche (28 June 2012). The post-bailout period follows the second bailout period.[10] These breakpoints for the sub-periods are also chosen according to the regime shifts as shown in Table 3.2.

[9] The first Greek bailout programme has been discontinued, and the remaining amount (€24.4 billion to be disbursed by the Eurozone countries) has been transferred to the EFSF.

[10] The sovereign CDS spread of Greece has remained unchanged due to Greek debt restructuring in early March 2012, thus there is no further analysis of Greek risk transfer for the bailout and post-bailout periods during the second Greek bailout.

The programme for Ireland (see Appendix 9) has been separated into four sub-periods. The pre-bailout period is separated into the period before application and the application period. The application period starts after 21 November 2010, which is the date of the official request by the government of Ireland, and ends before 25 January 2011, which is the issue date of the first tranche worth €5 billion. The bailout period is between the issue date of the first tranche and the settlement date of the final tranche on 03 April 2012, and the post-bailout period afterwards. The rescue programme for Portugal (see Appendix 10) is also set into four sub-periods, and the methodology to set sub-periods is similar to which of Ireland. Spain is not included in this section. Although the Spanish government issued the official request for financial bailout to the EFSF on 25 June 2012, the EFSF has not confirmed the settlement dates of bailouts.

Tables in Appendices 8, 9 and 10 show summary statistics of daily CDS spreads of the sovereign debts and banking debts in Greece, Ireland and Portugal, respectively, before, during and after the bailout events. The Greek sovereign CDS spreads (*gr*) have kept increasing from 354.77 bps to 14904.36 bps, and on the other hand, the CDS spreads of banking debts (*aca*) have started to decrease since the second bailout period. This difference in the sovereign and banking CDS spreads suggests as in the last section, that the financial sector might have transferred part of the credit default risk to the sovereign balance sheets in Greece. In the research of Acharya *et al*. (2011), similar results have also been found that the sovereign CDS spreads increase, meanwhile the banking CDS spreads decrease in the post-bailout period of the previous financial crisis, using the bankruptcy of Lehman Brothers as the break of the whole period.

The summary statistics of Ireland and Portugal (see Appendices 9 and 10) are different from the results of Greece. Both the banking and sovereign CDS spreads have kept increasing from the period of before application to the post-bailout period in Ireland. For Portugal, both the banking and sovereign CDS spreads have dropped significantly in the post-bailout period.

3.5.2. Default Risk Transfer during the First Greek Bailout

Table 3.3 reports the cointegration analysis results of the GIIPS countries before and after the first Greek bailout issued by the EFSF, respectively.

[Insert Table 3.3]

According to the VEC model (Equation (3.6)), β_{Sov} and β_{Fi} reveal the long-term relationship between the sovereign and the financial institution's default risks. Normalizing β_{Sov} to 1 then get:

$$cds_{Sov,t} = -\beta_{Fi} cds_{Fi,t} + \beta_0 \tag{3.7}$$

Thus a negative β_{Fi} indicates that the relationship between the two sectors is positive. The findings show that the β_{Fi} coefficients are significantly negative except the pair of *ES* and *SAB* before the bailout (see Panel A of Table 3.3), for periods before and after the first Greek bailout. The coefficients α_{Sov} and α_{Fi} measure the speed of adjustment towards the long-term relationship. The coefficients are significant and have opposite signs to their respective β coefficients, thus the CDS series are attracted back to the long-run equilibrium. Comparing Panel A and B of Table 3.3, it has been noticed that some α coefficients have changed from insignificant to significant after the first Greek bailout, i.e., the financial institutions *mdb* from Italy and *bkt*, *pop* and *sab* from Spain, which indicates that the CDS series of the financial institutions are moving towards their long-run equilibrium relationships. This provides some evidence to the argument that compared with the period before the bailout, the risk has transferred from the financial sector to the government after the bailout, and the default risk of the financial institutions are more influenced by the sovereign default risk.

Table 3.4 provides the results of cointegration analysis for non-GIIPS countries before and after the first Greek bailout, and the situation of non-GIIPS countries is similar that most of the β_{Fi} coefficients are significantly negative, suggesting a positive relationship between the sovereign and financial sectors in the long run.

[Insert Table 3.4]

Then the study analyses the results of impulse responses of all the countries. Table 3.5 shows the impulse responses of the GIIPS countries in both periods before and after the first Greek bailout. The responses after 1, 2 and 5 days represent the short-term effects, and the responses after 22 days show the long-run effects. For example, before the first Greek bailouts, the responses of *aca* to the impulse in *gr* after 1, 2 and 5 days are 0.09, 0.13 and 0.18, respectively, and the response after 22 days is 0.39. The responses of *gr* to the impulse in *aca* after 1, 2 and 5 days are 0.01, 0.01 and 0.02, respectively, and the response after 22 days is 0.06. This pattern is similar across countries. Thus it is observed that, before the bailout, a two-way feedback effect exists between the two sectors, as most of the responses of financial institutions to the sovereign CDS shocks are significantly positive, and vice versa, in both the short and long run. The results indicate that prior to the first Greek bailout, changes in the sovereign default risk affect the credit default risk of the domestic financial institutions, and vice versa.

[Insert Table 3.5]

In the period after the first Greek bailout, significant effect of default risk transfer is observed that, in both the short and long run, the responses of the financial institutions to the sovereign CDS shocks are significantly positive, and the responses are even larger than before. The results show that the domestic financial institutions are affected stronger by the shocks in sovereign default risk after the bailout.

On the other hand, the responses of the sovereign CDS to the domestic financial institutions become either insignificant or significantly negative for most variables after the bailout. Continuing with the example, while the response of *aca* to the impulse in *gr* remains positive (0.08) after the first Greek bailout, the response of *gr* to the impulse in *aca* becomes negatively significant (-0.21). This indicates that the default risk transfers from the financial sector to the government after the EFSF interventions, and the relieved default risk of the financial institutions becomes heavier debt burdens to the government instead. Changes in the default risk of the financial institutions have negative impacts on the sovereign default risk.

[Insert Figure 3.3, 3.4 and 3.5]

The graphs of impulse responses between each pair of variables in Greece, Ireland and Portugal (see Figure 3.3, 3.4 and 3.5) show the results more clearly, that after the first Greek bailout, in the short run, the responses of the sovereign default risks to their financial institutions become either close to very small values or negative.

Table 3.6 is the results of impulse responses for the non-GIIPS countries, which have contributed the most of the bailout package towards the GIIPS countries. Before the first Greek bailout, the two-way feedback effect is not significant for some countries such as France and Germany, and after the first Greek bailout, the responses of the financial sector to the sovereign default risk are still in the same direction. This indicates that the governments and their domestic financial sectors are not facing severe debt crisis, so the governments do not have to take over the default risk from the financial sector. The different results of GIIPS and non-GIIPS countries provide evidence to the argument that the heterogeneity of the rescue packages across the countries translates into the asymmetric interdependent relationship between the default risk of the sovereign and financial sectors.

[Insert Table 3.6]

The empirical results indicate that the default risk transfer might occur based on the current financial situations of the governments and their domestic financial sectors, and the capital injection directly to the financial sector might not relieve the sovereign debt crisis, but further magnify the impacts of sovereign default risk on financial sector through increasing the government debt burdens.

The results of this study are different from the results of Acharya *et al*. (2011). Acharya *et al*. (2011) use the credit default swap (CDS) spreads of the Eurozone countries for 2007-2010 and use the bankruptcy of Lehman Brothers as the break of the whole period. They use and OLS regression to analyse the sovereign-to-banking risk transfer. During the pre-bailout periods, there is no sovereign-to-banking risk transfer, but after the bailout, there is positive risk transfer.

In this study, however, before the first Greek bailout, the sovereign-to-financial and the financial-to-sovereign risk transfer have been positive, indicating that the countries have been entered into the feedback loop. However, after the bailout, the financial-to-sovereign risk transfer for the GIIPS countries becomes insignificant or negatively significant. Such results indicate that the GIIPS countries are the main beneficiaries of the bailouts, and the financial-to-sovereign risk transfer in the GIIPS countries breaks down after the bailouts, while the other bailout guarantees are still in the two-way feedback loop. Although these results are different from Acharya *et al*. (2011), they are not contrary. The data set in this research covers the periods after early 2011, and uses G1 (May 2010) as the breakpoint, which is after the breakpoint

Acharya *et al*. (2011) used. Thus the results of pre-bailout periods in this research is to some content consistent to Acharya *et al*. (2011), and the results make contributions to the period during and after the European sovereign debt crisis.

3.5.3. Results of Bailouts of Greece (Second Bailout), Ireland and Portugal

Table 3.7 shows the result of the impulse response functions (IRFs) for the Greek sovereign and banking CDS series. The results for the periods of the first bailout are similar to the results in Section 3.5.2, in which the responses of the financial sector to the shocks in the sovereign default risk are positively significant in the period before the first Greek bailout, and vice versa. In contrast, the responses of the sovereign default risk to the shocks in the financial sector become either insignificant or negatively significant in the short run, indicating that risk had been transferred from the financial sector to the government balance sheet. However, when analysing the results in the application period of the second Greek bailout, the responses of the financial sector default risk to the shocks in the sovereign default risk are insignificant, and so are the responses of the sovereign default risk to the shocks in the financial sector. Such results indicate that the risk transfer only happens in the period of the first Greek bailout.

[Insert Table 3.7]

The “Greek effect” indicates that the default risk for other countries such as Ireland and Portugal has been priced or perceived by the bond investors during the first bailout of Greece, and such default risk transfer becomes insignificant when other countries issue their own bailouts. Table 3.8 exhibits the result of the IRFs for the government and banking default risks in Ireland for the four sub-periods. The results are ambiguous compared to the results of Greece. In the period before the bailout application of Ireland, the responses of the financial sector to the shocks in the government default risk are positively significant, but the responses of the government to the shocks in the financial sector are insignificant. However, in the periods of application and bailout, the responses of the financial default risk to the shocks in the government become either insignificant or negatively significant, while the responses of the government to the shocks in the financial sector remain insignificant, which indicate the increased debt burden to the government should have decreased to some extent the default risk of the financial sector. But since the CDS spreads of both the sovereign and banking debts have been increasing, the results show that the crisis in the financial sector has not been relieved after the bailout to the government of Ireland. In the period after bailout, the IRF results are similar to the results before the application period.

[Insert Table 3.8]

Table 3.9 is the results of the IRFs for the sovereign and banking CDS series in Portugal. In the period of before bailout application and the post-bailout period, the responses of banking default risk to the shocks in the government default risk are positively significant, while the responses of the government default risk to the shocks in the financial sector are all insignificant. However, in both the application and bailout periods, the responses of the financial sector to the shocks in the sovereign default risk become insignificant, and vice versa.

[Insert Table 3.9]

When sub-periods are reset for Ireland and Portugal according to their own bailouts received, respectively, the default risk transfer from the banking sector to the government is not significant, compared to the results in Section 3.5.2, in which section the analysis set the same two sub-periods for all the countries based on the first Greek bailout. The risk transfer from the financial sector to the sovereign default risk is significant to the countries that have potential defaults, only when the first Greek bailout is issued. Such difference indicates that the risk of default had already been priced for Ireland, Portugal and Spain. Given the Greek experience, bond investors have perceived that for these countries in the future, might also request and sequentially receive the bailouts from the EFSF guarantees. For Ireland, Portugal, the transfer of risk of default in the banking sector to the government default risk was priced after the Greek bailout approved. Thus by the time these countries requested their own bailouts, such effect disappears.

3.6. Conclusion

This chapter analyses the default risk transfer between the sovereign and the financial institutions' CDS series during the European sovereign debt crisis in 2010. The results show that before the first Greek bailout by the EFSF in May 2010, two-way feedback effects exist between the two sectors in both the short and the long runs. After the first Greek bailout, the shocks in the financial institutions' CDS spreads either exert significantly negative impacts on the sovereign CDS spreads or lose their influences.

The study further analyses the effect of default risk transfer in Greece (second bailout), Ireland and Portugal, and set sub-periods according to the bailouts to these three countries by the EFSF. The findings show that the transmissions of default risk from the financial sector to sovereign debt in each of the three countries are insignificant both before and after each of the bailouts. The default risk transfer is significant only when the first Greek bailout was issued. The transmission of default risk disappeared when the other countries requested for their own bailouts. This is called the "Greek effect". The implication of the findings is that the first bailout by the EFSF to Greece helps alleviate the financial systemic risk and break the private-to-public risk transfer. Since the investors perceived the forthcoming bailouts to the GIIPS countries, the EFSF has actually become the central bank of the whole Eurozone, and the default risk dropped in one single country will be shared in the long run by all the Eurozone countries.

There are limitations to the EFSF bailout programme, as the EFSF only raises funds after an official aid request is made by a country. The EFSF funds are given to the governments, which in turn bailout individual institutions in the country, leading increases in the government default risk. The EFSF has been improved to the European Stability Mechanism (ESM), a permanent bailout funding programme, and the current Spanish bailout has been passed on to the ESM in early 2013. The funds by the ESM are transferred in the form of ESM notes to individual banks through FROB, and these banks have been confirmed to receive certain amounts according to the bailout scheme. Further research could also be focused on the Spanish case in order to make comparison of different bailout policies.

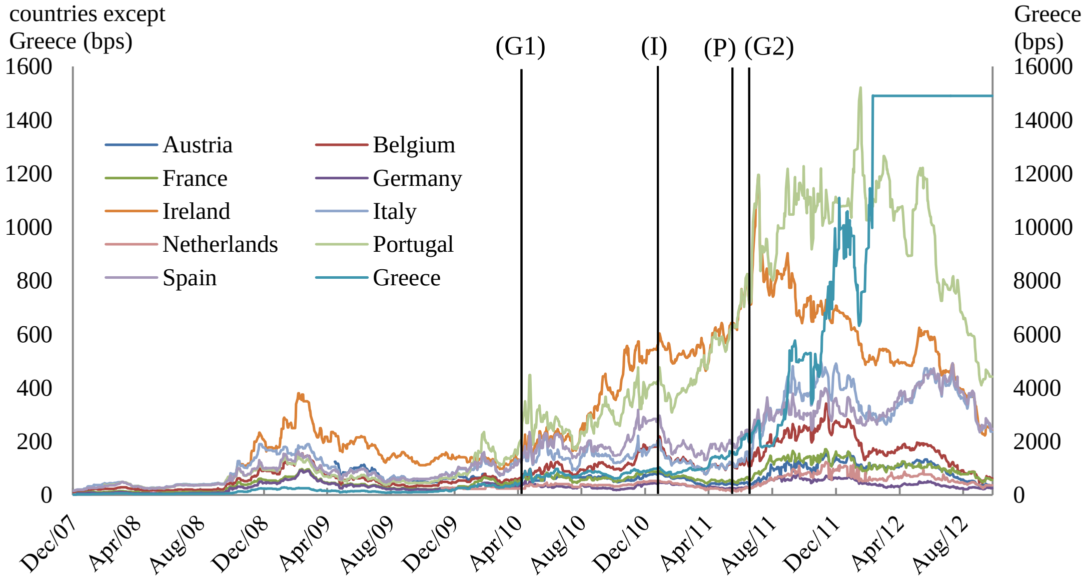
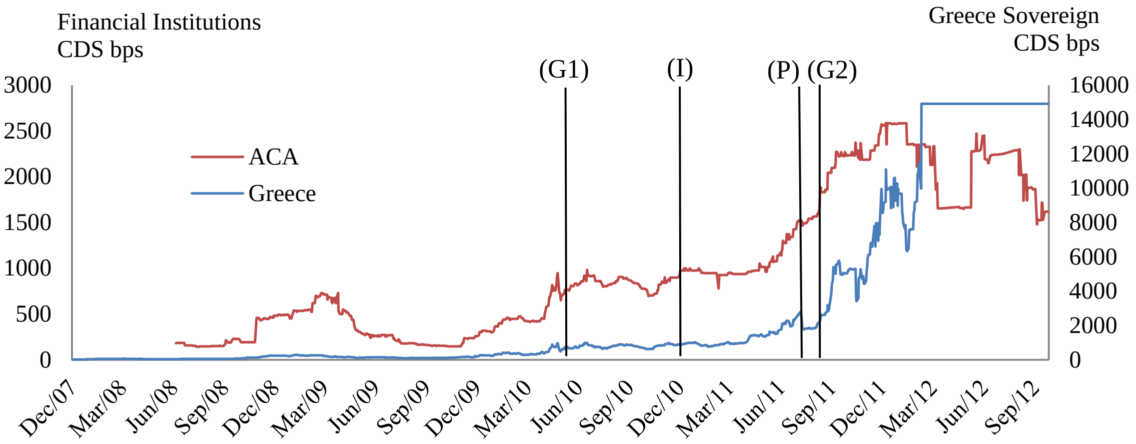


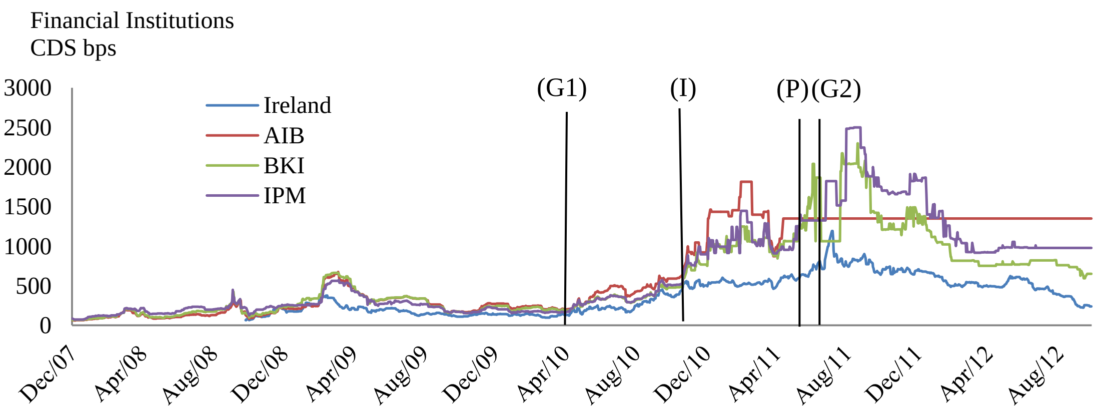
Figure 3.1. Sovereign CDS Spreads for Ten Countries

Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as G1, I, P, and G2. The first Greek bailout is on 9 May 2010 (G1), and Greece officially requested for the second bailout on 21 July 2011 (G2). The settlement date of the tranche of Irish bailout is on 25 January 2011 (I), and for Portugal is on 15 June 2011 (P). Since Greek debt restructuring triggered approximately $3.2bn CDS credit protection payouts on Greek sovereign debt in early March 2012, the sovereign CDS spread of Greece has remained unchanged.

Panel A. CDS Spreads of Greek Sovereign Debt and Domestic Financial Institution



Panel B. CDS Spreads of Irish Sovereign Debt and Domestic Financial Institutions



Panel C. CDS Spreads of Portugal Sovereign Debt and Domestic Financial Institutions

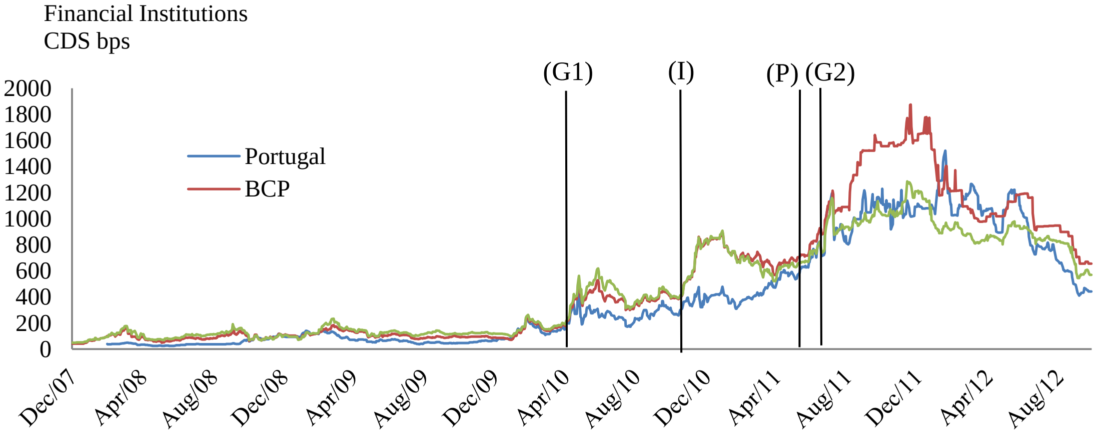
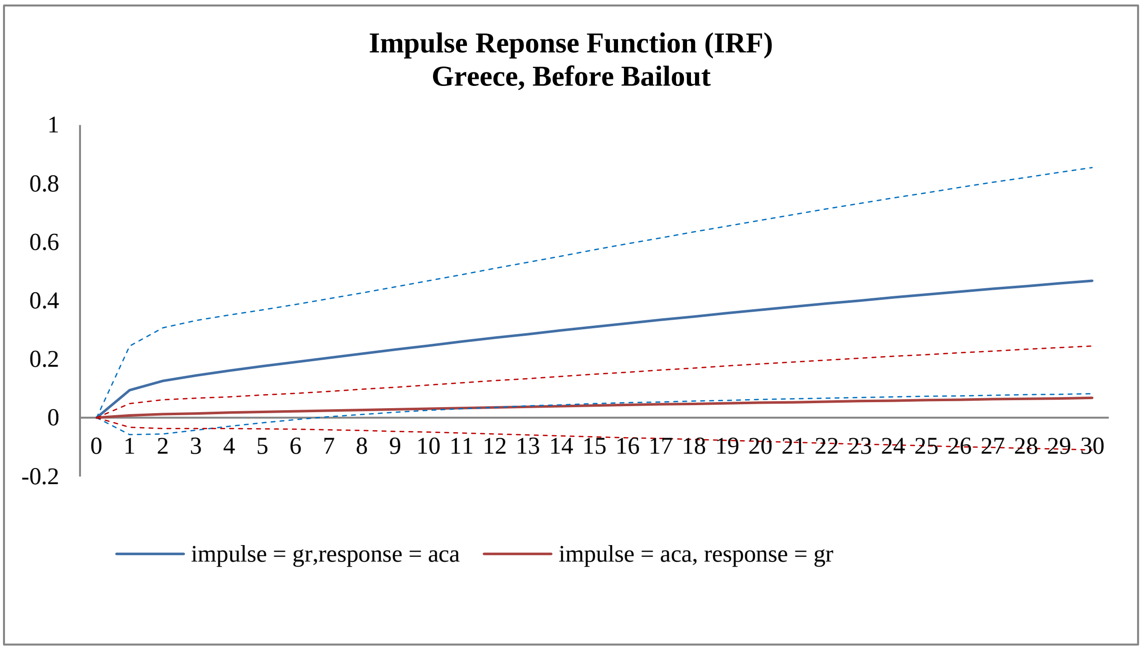


Figure 3.2. CDS Spreads for Greece, Ireland and Portugal

Four settlement dates of EFSF bailouts to Greece, Ireland and Portugal are denoted as G1, I, P, and G2. The first Greek bailout is on 9 May 2010 (G1), and Greece officially requested for the second bailout on 21 July 2011 (G2). The settlement date of the tranche of Irish bailout is on 25 January 2011 (I), and for Portugal is on 15 June 2011 (P). Since Greek debt restructuring triggered approximately \$3.2bn CDS credit protection payouts on Greek sovereign debt in early March 2012, the sovereign CDS spread of Greece has remained unchanged. The three-letter variables represent domestic financial institutions in the corresponding country.

Panel A. IRFs for Greek before the First Greek Bailout



Panel B. IRFs for Greek after the First Greek Bailout

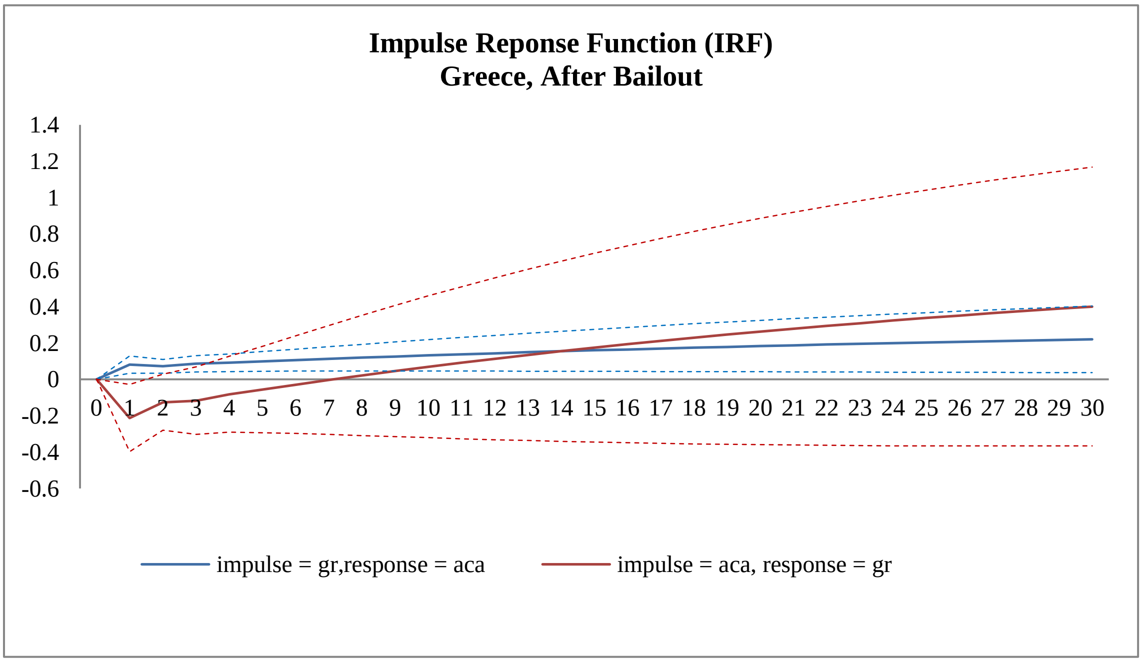
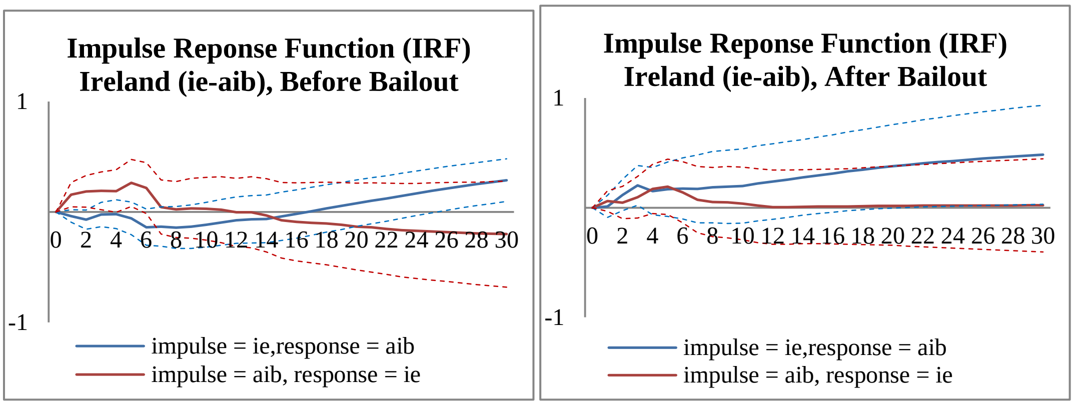


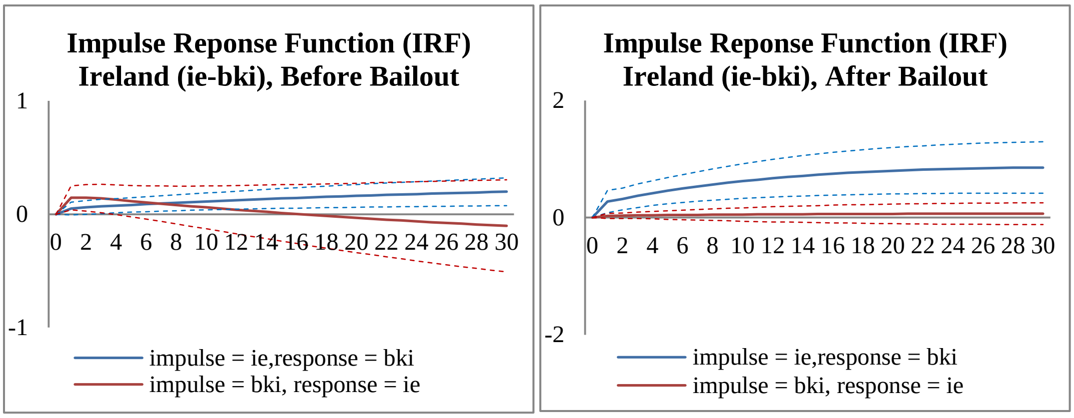
Figure 3.3. Impulse Response Function for Greece before and after the First Greek Bailout

The solid blue lines are impulse responses of the financial institution to the shocks in its country sovereign debt, and the solid red lines are impulse responses of the sovereign debt to the shocks in the domestic financial institutions. Dotted lines are the 95% confident intervals. Upper graph shows the impulse responses between the pair before the first Greek bailout, and the lower graph shows the impulse responses after the first Greek bailout. The two-letter variable indicates the sovereign debt, and the three-letter variable is a domestic financial institution.

Panel A. IRFs for Ireland (ie-aib) before and after the First Greek Bailout



Panel B. IRFs for Ireland (ie-bki) before and after the First Greek Bailout



Panel C. IRFs for Ireland (ie-ipm) before and after the First Greek Bailout

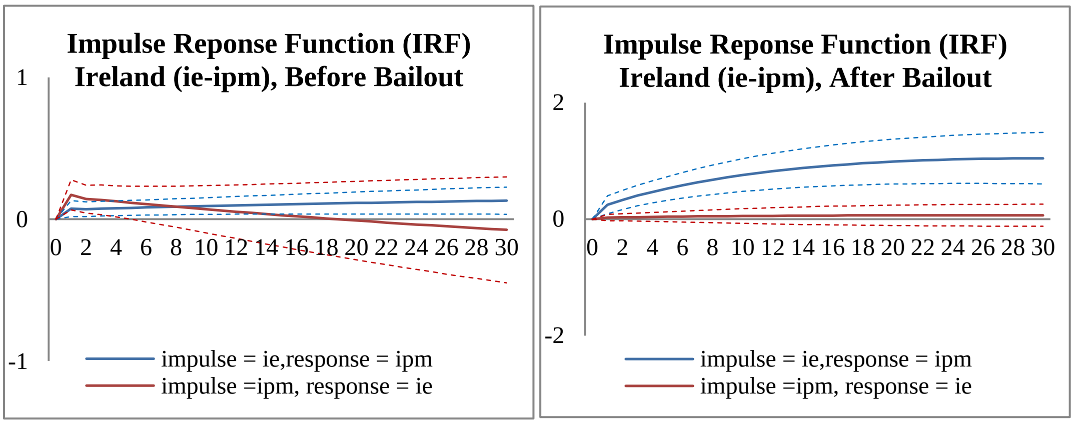
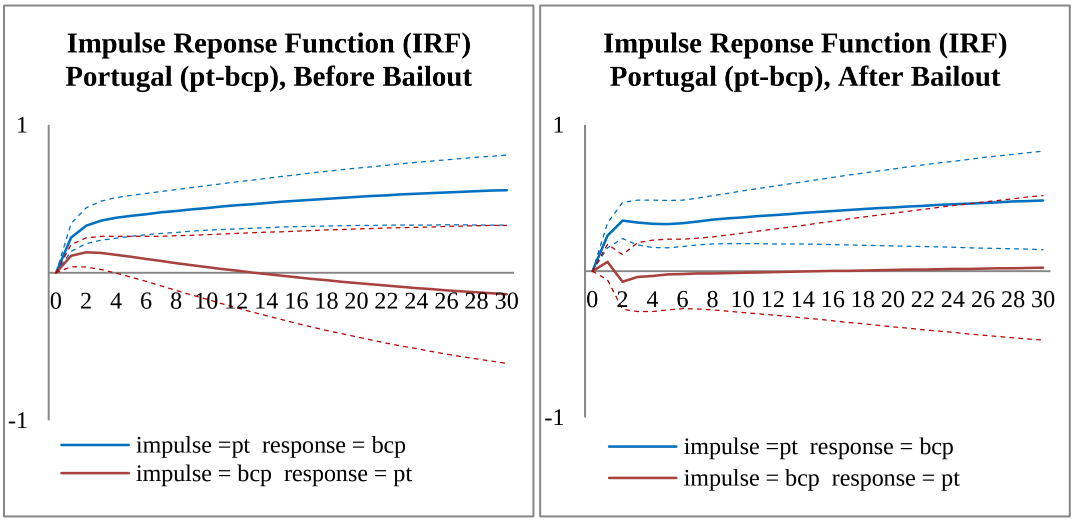


Figure 3.4. Impulse Response Function for Ireland before and after the First Greek Bailout

The solid blue lines are impulse responses of the financial institution to the shocks in its country sovereign debt, and the solid red lines are impulse responses of the sovereign debt to the shocks in the domestic financial institutions. Dotted lines are the 95% confident intervals. Left graphs show the impulse responses between the pair before the first Greek bailout, and the graphs on the right side show the impulse responses after the first Greek bailout. The two-letter variable indicates the sovereign debt, and the three-letter variable is a domestic financial institution.

Panel A. IRFs for Portugal (pt-bcp) before and after the First Greek Bailout



Panel B. IRFs for Portugal (pt-bes) before and after the First Greek Bailout

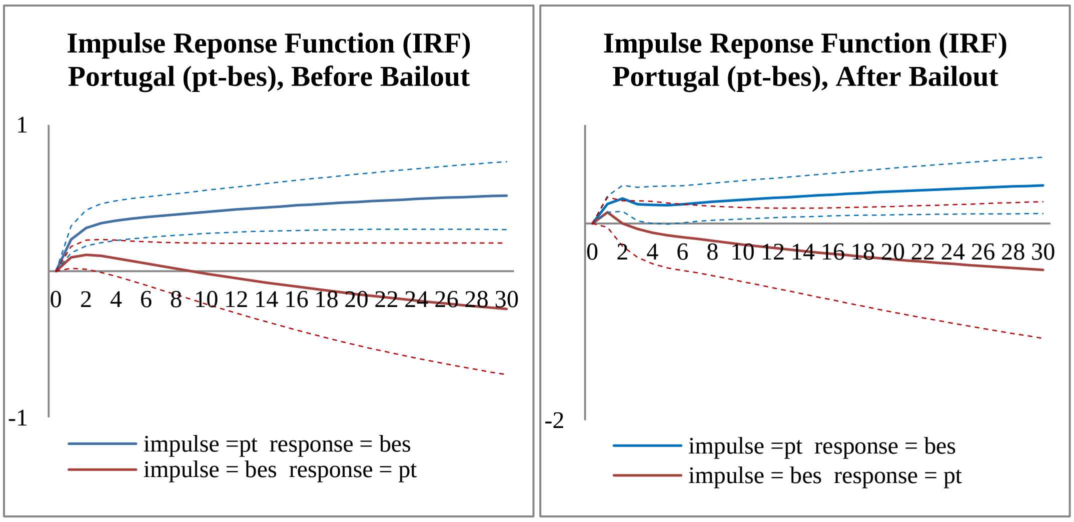


Figure 3.5. Impulse Response Function for Portugal before and after the First Greek Bailout

The solid blue lines are impulse responses of the financial institution to the shocks in its country sovereign debt, and the solid red lines are impulse responses of the sovereign debt to the shocks in the domestic financial institutions. Dotted lines are the 95% confident intervals. Left graphs show the impulse responses between the pair before the first Greek bailout, and the graphs on the right side show the impulse responses after the first Greek bailout. The two-letter variable indicates the sovereign debt, and the three-letter variable is a domestic financial institution.

Table 3.1. Testing Cointegration of *gr* and *aca* with Regime Shifts

The table shows an example of test for cointegration of two variables, the Greek sovereign debt (*gr*) and Alpha Bank (*aca*). The test statistics with *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively. The breakpoints show the positions of the smallest test statistics in the whole time period, and the exact dates are shown if the estimates are significant. C, C/T, C/S, and C/S/T are tests for models with level shift, level shift with trend, regime shift, and regime shift with trend, respectively.

Model 1: Level shift (C)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t, \qquad t = 1, \ldots, n.$$

Model 2: Level shift with trend (C/T)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta t + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t, \qquad t = 1, \ldots, n.$$

Model 3: Regime shift (C/S)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t}\varphi_{t\tau} + e_t, \qquad t = 1, \ldots, n.$$

Model 4: Regime and trend shift (C/S/T)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta_1 t + \beta_2 t\varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t}\varphi_{t\tau} + e_t, \quad t = 1, \ldots, n.$$

	Test stat.	Breakpoint	Date
ADF			
C	-4.06	(0.27)	
C/T	-3.97	(0.27)	
C/S	-4.85*	(0.85)	21-09-2011
C/S/T	-5.02	(0.81)	
Z_t			
C	-3.8	(0.85)	
C/T	-4.1	(0.85)	
C/S	-4.49	(0.85)	
C/S/T	-5.55**	(0.37)	12-05-2010
Z_a			
C	-28.65	(0.85)	
C/T	-35.22	(0.85)	
C/S	-31.04	(0.85)	
C/S/T	-60.6**	(0.37)	12-05-2010

Table 3.2. Summary of Earliest and Latest Breakpoints for Greece, Ireland, Portugal, Spain and Italy

The table shows the exact dates of the significant breakpoints tested by the C, C/T, C/S, and/or C/S/T models. The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are corresponding domestic financial institutions.

Model 1: Level shift (C)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t, \qquad t = 1, \ldots, n.$$

Model 2: Level shift with trend (C/T)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta t + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t, \qquad t = 1, \ldots, n.$$

Model 3: Regime shift (C/S)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t}\varphi_{t\tau} + e_t, \qquad t = 1, \ldots, n.$$

Model 4: Regime and trend shift (C/S/T)

$$cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta_1 t + \beta_2 t\varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t}\varphi_{t\tau} + e_t, \quad t = 1, \ldots, n.$$

Variables		Earliest breakpoint	Latest breakpoint
gr	aca	12-05-2010	21-09-2011
ie	aib	09-12-2010	09-12-2010
ie	bki	25-11-2010	29-12-2010
ie	ipm	29-12-2010	09-08-2011
pt	bcp	21-12-2009	21-12-2009
pt	bes	11-12-2009	04-01-2010
es	bkt	30-11-2009	10-03-2011
es	pop	06-11-2009	11-01-2011
es	sab	06-11-2009	06-11-2009
es	san	21-01-2010	12-01-2011
it	bci	20-12-2010	11-01-2011
it	pii	11-01-2011	24-01-2011
it	bmp	23-06-2010	17-08-2010
it	gas	21-01-2010	20-12-2010
it	mdb	17-12-2010	24-01-2011
it	ubi	29-04-2010	13-09-2010
it	uni	27-12-2010	11-01-2011

Table 3.3. Cointegration Analysis of GIIPS Countries

The table shows the results from the following cointegration model:

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} \left(\beta_{Sov} cds_{Sov,t-1} + \beta_{Fi} cds_{Fi,t-1} + \beta_0 \right)$$
$$+ \sum_{i=1}^{p-1} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t \, .$$

The table only presents the cointegration analysis for the bi-variables that are tested to be cointegrated in the Johansen's trace tests. The test statistics with * indicate significant at the 10%. *Sov* indicates a sovereign debt, and *Fi* indicates a financial institution from the country. The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. *β_Sov* is set as 1. *β* coefficients measure the long-run relationships between the two variables, and the *α* coefficients are adjustment speeds of the two variables towards their long-term relationships.

Panel A. Before first Greek bailout

Country	Sov	Fi	α_Sov	α_Fi	β_Fi	Constant
Greece	gr	aca	-0.00	0.02*	-0.83*	-0.24
Ireland	ie	aib	-	-	-	-
	ie	bki	0.00	0.01*	-3.30*	13.81
	ie	ipm	0.00*	0.00*	-10.03*	51.93
Italy	it	bci	-	-	-	-
	it	mdb	-0.01*	0.00	-0.89*	-0.79
	it	bmp	-	-	-	-
	it	pii	0.00*	0.00*	-21.98*	96.60
	it	uni	-	-	-	-
	it	ubi	-	-	-	-
	it	gas	-	-	-	-
Portugal	pt	bcp	0.00	0.02*	-1.41*	2.45
	pt	bes	0.00	0.01*	-1.56*	3.47
Spain	es	bbv	-	-	-	-
	es	bkt	-0.03*	0.02	-0.42*	-6.25
	es	pop	-0.02*	0.00	-0.29*	-1.99
	es	sab	-0.00*	-0.00	3.59*	-24.48
	es	san	-	-	-	-

Table 3.3 *(continued)*

Panel B. After first Greek bailout

Country	Sov	Fi	α_Sov	α_Fi	β_Fi	Constant
Greece	gr	aca	-0.01	0.01*	-2.08*	7.13
Ireland	ie	aib	0.01	0.02*	-1.30*	2.83
	ie	bki	-	-	-	-
	ie	ipm	-	-	-	-
Italy	it	bci	-0.01	0.02*	-0.85*	-0.99
	it	mdb	-0.01	0.04*	-0.90*	-0.66
	it	bmp	0.00	0.02*	-1.13*	0.97
	it	pii	-0.03*	-0.01	-0.68*	-1.83
	it	uni	-0.01	0.01	-0.92*	-0.50
	it	ubi	-0.03*	0.02	-0.95*	-0.28
	it	gas	0.00	0.02*	-1.08*	0.25
Portugal	pt	bcp	-0.00	0.02*	-1.05*	0.63
	pt	bes	0.01*	0.01*	-1.99*	6.84
Spain	es	bbv	-	-	-	-
	es	bkt	-0.04*	0.05*	-0.58*	-2.18
	es	pop	-0.06*	0.05*	-0.58*	-2.10
	es	sab	-0.03	0.03*	-0.61*	-1.98
	es	san	-	-	-	-

Table 3.4. Cointegration Analysis of Non-GIIPS Countries

The table shows the results from the following cointegration model:

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} \left(\beta_{Sov} cds_{Sov,t-1} + \beta_{Fi} cds_{Fi,t-1} + \beta_0 \right) + \sum_{i=1}^{p-1} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t \, .$$

The table only presents the cointegration analysis for the bi-variables that are tested to be cointegrated in the Johansen's trace tests. The test statistics with * indicate significant at the 10%. *Sov* indicates a sovereign debt, and *Fi* indicates a financial institution from the country. The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. β_Sov is set as 1. β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships.

Panel A. Before first Greek bailout

Country	Sov	Fi	α_Sov	α_Fi	β_Fi	Constant
Austria	at	rzb	-0.00	0.01*	-2.83*	10.84
	at	ers	0.00*	0.00*	-6.91*	31.67
Belgium	be	kbc	-0.00	0.01*	-1.27*	2.54
France	fr	bnp	-	-	-	-
	fr	car	0.00*	0.00*	-14.52*	62.95
	fr	sge	0.00	0.01*	-5.01*	19.58
	fr	cnt	0.00	0.00*	-7.47*	36.78
	fr	axa	-0.00	-0.00*	7.02*	-37.67
	fr	sco	-0.00*	-0.00	5.26*	-28.00
	fr	gfc	-0.00*	-0.00	0.90	-9.70
	fr	wed	0.00*	0.00*	-3.02*	15.92
Germany	de	ikb	-0.00	-0.00*	1.90*	-15.64
	de	dbk	0.00	0.01*	-3.94*	14.99
	de	cbg	0.00*	0.00*	-21.42*	93.45
	de	muv	-	-	-	-
	de	alv	0.00	0.00*	-7.21*	28.65
	de	hnr	0.00	0.00*	-13.22*	53.22
Netherlands	nl	abn	-0.00	0.00*	-12.40*	52.82
	nl	aen	-0.01*	-0.00	0.16	-4.69
	nl	ina	0.00	0.00*	-3.57*	14.30
	nl	inb	-0.00	0.00*	-9.54*	39.08
	nl	sns	-0.00	0.01*	-2.20*	8.65

Table 3.4 *(continued)*

Country	Sov	Fi	α_Sov	α_Fi	β_Fi	Constant
Austria	at	rzb	0.001	0.03*	-1.52*	3.437
	at	ers	-0.031	0.04*	-1.05*	0.900
Belgium	be	kbc	0.005	0.04*	-0.82*	-0.730
France	fr	bnp	-0.04*	0.003	-0.83*	-0.318
	fr	car	-0.024	0.03*	-1.24*	1.981
	fr	sge	-0.05*	0.011	-0.80*	-0.250
	fr	cnt	-0.014	0.04*	-1.47*	3.260
	fr	axa	-0.04*	0.014	-0.88*	0.142
	fr	sco	-0.03*	0.011	-1.05*	0.705
	fr	gfc	-0.012	0.006	-0.463	-1.979
	fr	wed	-0.02*	0.001	-0.75*	0.103
Germany	de	ikb	-0.004	0.01*	-4.42*	22.622
	de	dbk	0.001	0.02*	-1.50*	3.260
	de	cbg	-0.015	0.02*	-1.10*	1.563
	de	muv	0.001	0.01*	-3.94*	12.816
	de	alv	0.005	0.03*	-1.72*	3.732
	de	hnr	0.000	0.00*	-30.31*	139.550
Netherlands	nl	abn	0.001	0.00*	-27.55*	134.414
	nl	aen	-0.002	0.01*	-2.98*	11.751
	nl	ina	-0.005	-0.01*	2.57*	-17.709
	nl	inb	-0.02*	0.013	-1.60*	3.823
	nl	sns	-0.018	0.04*	-2.12*	7.601

Table 3.5. Impulse Responses of GIIPS Countries before and after the First Greek Bailout

The table shows the impulse responses from the following model:

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t .$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. 1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10%. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Country	Impulse	Response	Before Bailout				After Bailout			
			1	2	5	22	1	2	5	22
Greece	gr	aca	0.09	0.13	0.18*	0.39*	0.08*	0.07*	0.10*	0.19*
	aca	gr	0.01	0.01	0.02	0.06	-0.21*	-0.13	-0.06	0.29
Ireland	ie	aib	-0.04	-0.07	-0.06	0.12	0.01	0.12	0.17	0.40*
	aib	ie	0.16*	0.19*	0.26*	-0.15	0.06	0.05	0.19	0.02
	ie	bki	0.05*	0.06*	0.08*	0.17*	0.28*	0.32*	0.46*	0.82*
	bki	ie	0.14*	0.14*	0.12*	-0.05	0.03	0.03	0.04	0.06
	ie	ipm	0.08*	0.07*	0.08*	0.12*	0.25*	0.33*	0.53*	1.01*
	ipm	ie	0.17*	0.14*	0.12*	-0.02	0.03	0.03	0.04	0.07
Italy	it	bci	0.15*	0.15*	0.18*	0.27*	0.38*	0.47*	0.53*	0.68*
	bci	it	0.19*	0.17*	0.14*	-0.02	-0.11*	-0.13*	-0.11	-0.02
	it	mdb	0.15*	0.15*	0.16*	0.20*	0.22*	0.35*	0.41*	0.65*
	mdb	it	0.18*	0.18*	0.18*	0.11	-0.13*	-0.24*	-0.18	0.02
	it	bmp	0.01	0.03	0.06	0.18*	0.25*	0.35*	0.39*	0.53*
	bmp	it	0.16*	0.16*	0.10	-0.16	-0.16*	-0.34*	-0.37*	-0.28
	it	pii	0.07*	0.07*	0.09*	0.15*	0.23*	0.39*	0.30*	0.07
	pii	it	0.20*	0.19*	0.15*	-0.05	-0.01	-0.10	-0.02	0.31*
	it	uni	-0.05	-0.04	0.03	0.31*	0.21*	0.33*	0.34*	0.38
	uni	it	0.18*	0.13*	0.11*	-0.04	-0.07	-0.13	-0.09	0.12
	it	ubi	0.02*	0.04*	0.08*	0.24*	0.22*	0.41*	0.40*	0.40*
	ubi	it	0.00	0.00	-0.01	-0.03	-0.04	-0.19	-0.11	0.25
	it	gas	0.08*	0.09*	0.11*	0.18*	0.25*	0.40*	0.45*	0.60*
	gas	it	0.15*	0.15*	0.10*	-0.12	-0.16*	-0.30*	-0.30*	-0.24
Portugal	pt	bcp	0.24*	0.32*	0.38*	0.52*	0.24*	0.35*	0.32*	0.45*
	bcp	pt	0.11*	0.14*	0.11	-0.09	0.06	-0.07	-0.02	0.01
	pt	bes	0.22*	0.30*	0.36*	0.48*	0.20*	0.25*	0.19*	0.34*
	bes	pt	0.10*	0.11*	0.07	-0.18	0.11	0.00	-0.12	-0.39
Spain	es	bbv	0.17*	0.18*	0.21*	0.26*	0.35*	0.42*	0.42*	0.62*
	bbv	es	0.21*	0.20*	0.15*	-0.08	0.06	-0.07	-0.19	-0.45*
	es	bkt	0.02*	0.04*	0.10*	0.31	0.19*	0.24*	0.33*	0.53*
	bkt	es	0.01*	0.02*	0.04*	0.14*	-0.09*	-0.07	-0.01	0.17
	es	pop	0.01	0.01	0.02	0.09	0.10*	0.18*	0.35*	0.61*
	pop	es	0.00	0.01	0.02	0.07	-0.04	-0.03	0.09	0.31*
	es	sab	0.09*	0.10*	0.11*	0.18*	0.15*	0.23*	0.34*	0.46*
	sab	es	0.17*	0.16*	0.12*	-0.08	0.06	0.00	-0.11	0.14
	es	san	0.16*	0.16*	0.19*	0.23*	0.25*	0.42*	0.34*	0.55*
	san	es	0.18*	0.16*	0.11*	-0.09	0.13*	0.00	-0.07	-0.07

Table 3.6. Impulse Responses of non-GIIPS Countries before and after the First Greek Bailout

The table shows the impulse responses from the following model:

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t .$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. 1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10%. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Country	Impulse	Response	Before Bailout				After Bailout			
			1	2	5	22	1	2	5	22
Austria	at	rzb	0.18*	0.20*	0.12*	0.21*	0.11*	0.19*	0.25*	0.44*
	rzb	at	0.23*	0.31*	0.32*	0.17	0.17*	0.01	-0.17	-0.15
	at	ers	0.14*	0.17*	0.41*	0.35*	0.06	0.22*	0.26*	0.47*
	ers	at	0.08	-0.02	0.10*	-0.01	0.18*	0.18	-0.03	0.34
Belgium	be	kbc	-0.01	-0.06	-0.04	0.31*	0.14*	0.27*	0.35*	0.67*
	kbc	be	0.08	0.10*	0.23*	0.15	0.15*	0.04	-0.23*	-0.23
France	fr	bnp	0.06	0.08	0.11*	0.20*	0.09*	0.21*	0.09	0.09
	bnp	fr	0.09*	0.11*	0.06	-0.17	0.28*	0.36*	0.20	0.41*
	fr	car	0.03	0.04	0.06	0.12*	0.11*	0.19*	0.10	0.29
	car	fr	0.05	0.04	-0.03	-0.37*	0.33*	0.42*	0.31*	0.31
	fr	sge	0.06*	0.08*	0.11*	0.18*	0.09*	0.19*	0.11	0.18
	sge	fr	0.18*	0.21*	0.16*	-0.14	0.32*	0.44*	0.33*	0.49*
	fr	cnt	0.03	0.03	0.05	0.10	0.09*	0.14*	0.24*	0.46*
	cnt	fr	0.10*	0.10*	0.09*	0.03	0.12	0.15	0.14	0.09
	fr	axa	0.07*	0.19*	0.22*	0.16*	0.07*	0.09*	0.14*	0.24
	axa	fr	0.03	0.01	0.00	-0.05	0.20*	0.28*	0.35*	0.51*
	fr	sco	0.09*	0.10*	0.11*	0.12*	0.05*	0.07*	0.11*	0.21
	sco	fr	0.00	0.00	-0.03	-0.15	0.15	0.20*	0.28*	0.47*
	fr	gfc	0.03	0.04	0.05	0.06	0.06*	0.09*	0.11*	0.19*
	gfc	fr	0.06	0.07	0.06	0.00	0.05	0.05	0.03	-0.09
	fr	wed	0.01	0.08	0.14	0.27*	0.10*	0.13*	0.13*	0.12
	wed	fr	0.02	0.05	-0.02	-0.24*	0.07	0.10	0.13	0.24
Germany	de	ikb	0.06	0.07	0.07	0.03	0.07*	0.07*	0.09*	0.15*
	ikb	de	0.01	0.01	0.01	0.01	0.04	0.05	0.08	0.18
	de	dbk	0.08*	0.11*	0.14*	0.20*	0.06	0.09	0.14*	0.31*
	dbk	de	0.07*	0.09*	0.07	-0.02	0.06	0.06	0.06	0.00
	de	cbg	0.04	0.05	0.07	0.10	0.14*	0.17*	0.21*	0.31
	cbg	de	0.10*	0.11*	0.05	-0.25	0.08*	0.11*	0.15*	0.29
	de	muv	0.12*	0.16*	0.17*	0.11	0.09	0.23*	0.09	0.13
	muv	de	0.04	0.05	0.03	-0.11	0.05	0.04	-0.14	-0.10
	de	alv	0.10*	0.14*	0.15*	0.16*	0.06	0.21*	0.09	0.36*
	alv	de	0.03	0.03	0.00	-0.17	0.09*	0.11	0.00	-0.07
	de	hnr	0.06	0.01	-0.01	0.03	0.00	0.04	-0.15	-0.10
	hnr	de	0.03	0.02	0.00	-0.10	0.18*	0.14	0.01	0.03
Netherlands	nl	abn	0.04	0.04	0.04	0.04	0.07*	0.10*	0.10*	0.07
	abn	nl	0.09*	0.09*	0.10	0.10	0.13	0.15	0.09	-0.21
	nl	aen	0.01	0.01	0.01	0.00	0.04*	0.07*	0.10*	0.20*
	aen	nl	0.14*	0.17*	0.20*	0.31*	0.25*	0.34*	0.36*	0.32
	nl	ina	0.11*	0.10*	0.12*	0.16*	0.18*	0.20*	0.17*	-0.01
	ina	nl	0.09*	0.08*	0.08*	0.06	0.04	0.03	-0.01	-0.21
	nl	inb	0.06*	0.06*	0.06*	0.04	0.16*	0.20*	0.21*	0.19
	inb	nl	0.16*	0.18*	0.20*	0.27	0.09	0.15*	0.26*	0.64*
	nl	sns	0.01	-0.03	0.01	0.11	0.05	0.09*	0.19*	0.40*
	sns	nl	0.09*	0.12*	0.25*	0.23*	0.23*	0.26*	0.31*	0.38*

Table 3.7. Impulse Responses of Greece for the First and Second Greek Bailouts

The table shows the impulse responses from the following model:

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t \,.$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. 1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10%. The IRF results of bi-variables not cointegrated are also presented for comparisons.

		Panel A. Whole period			
			days		
impulse	response	1	2	5	22
gr	aca	0.09*	0.07*	0.07*	0.07*
aca	gr	-0.02	-0.01	0.00	0.06
		Panel B. First Greek bailout			
		Before bailout (19/11/2009-07/05/2010)			
impulse	response	1	2	5	22
gr	aca	0.06*	0.12*	0.24*	0.50*
aca	gr	0.10	0.19	0.40	0.82
		Bailout period (10/05/2010-20/07/2011)			
impulse	response	1	2	5	22
gr	aca	0.19*	0.18*	0.27*	0.54*
aca	gr	-0.02	-0.05	-0.13	-0.42
		Panel C. Second Greek bailout			
		Application period (21/07/2011-20/02/2012)			
impulse	response	1	2	5	22
gr	aca	0.01	0.02	0.03	0.06
aca	gr	-0.59*	-0.15	-0.10	0.38

Table 3.8. Impulse Responses of Ireland for the Irish Bailout

The table shows the impulse responses from the following model:

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t .$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. 1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10%. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Panel A. Whole period					
			days		
impulse	response	1	2	5	22
ie	aib	0.01*	0.03*	0.07*	0.28*
aib	ie	-0.01*	-0.02*	-0.05*	-0.18
ie	bki	0.19*	0.22*	0.33*	0.74*
bki	ie	0.02	0.02	0.01	-0.02
ie	ipm	0.18*	0.21*	0.31*	0.71*
ipm	ie	-0.01	-0.02	-0.02	-0.04
Panel B. Irish Bailout					
Before application (19/11/2009-19/11/2010)					
impulse	response	1	2	5	22
ie	aib	0.07*	0.14*	0.33*	0.97*
aib	ie	-0.03	-0.06	-0.13	-0.38
ie	bki	0.09*	0.17*	0.38*	0.94*
bki	ie	-0.05	-0.09	-0.21	-0.51
ie	ipm	0.09*	0.18*	0.39*	0.96*
ipm	ie	-0.01	-0.02	-0.06	-0.14
Application period (22/11/2010-24/01/2011)					
impulse	response	1	2	5	22
ie	aib	-0.37*	-0.60*	-0.85*	-0.34
aib	ie	0.05*	0.09*	0.12*	0.05
ie	bki	0.00	-0.01	-0.01	0.00
bki	ie	0.04	0.06	0.08	0.01
ie	ipm	0.89*	0.49*	0.41	0.01
ipm	ie	-0.08	-0.05	-0.05	0.00
Bailout period (25/01/2011-01/04/2012)					
impulse	response	1	2	5	22
ie	aib	-0.41*	-0.76*	-1.46*	-1.84
aib	ie	-0.01	-0.02	-0.03	-0.04
ie	bki	-0.30	-0.47	-0.53	-0.01
bki	ie	0.08	0.12*	0.13*	0.00
ie	ipm	-0.16	-0.26	-0.36	-0.07
ipm	ie	0.01	0.02	0.03	0.01
After bailout (04/04/2012-08/10/2012)					
impulse	response	1	2	5	22
ie	aib	-0.01	0.01	0.00	0.00
aib	ie	0.27	0.14	0.03	-0.09
ie	bki	0.28*	0.32*	0.42*	0.76*
bki	ie	0.03	0.03	0.04	0.06
ie	ipm	0.10	0.12	0.18*	0.43*
ipm	ie	0.03	0.03	0.04	0.05

Table 3.9. Impulse Responses of Portugal for the Portugal Bailout

The table shows the impulse responses from the following model:

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t \,.$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. 1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10%. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Panel A. Whole period					
		days			
impulse	response	1	2	5	22
pt	bcp	0.20*	0.27*	0.33*	0.50*
bcp	pt	-0.07	-0.09	-0.09	-0.05
pt	bes	0.20*	0.30*	0.26*	0.38*
bes	pt	-0.07	-0.06	-0.10	-0.31
Panel B. Portugal bailout					
Before application (19/11/2009-06/04/2011)					
impulse	response	1	2	5	22
pt	bcp	0.26*	0.38*	0.51*	0.74*
bcp	pt	-0.17	-0.20	-0.13	0.09
pt	bes	0.23*	0.32*	0.43*	0.67*
bes	pt	-0.17	-0.21	-0.19	-0.06
Application period (07/04/2011-14/06/2011)					
impulse	response	1	2	5	22
pt	bcp	0.07	0.13	0.25	0.30
bcp	pt	0.08	0.14	0.27	0.33
pt	bes	0.15	0.25	0.40	0.30
bes	pt	0.05	0.09	0.14	0.10
Bailout period (15/06/2011-17/07/2012)					
impulse	response	1	2	5	22
pt	bcp	0	0	0	0
bcp	pt	0.01	0.02	0.04	0.1
pt	bes	0.13*	0.15*	0.1	-0.08
bes	pt	0.05	0.06	0.03	-0.07
After bailout (18/07/2012-08/10/2012)					
impulse	response	1	2	5	22
pt	bcp	0.12*	0.22*	0.45*	0.76*
bcp	pt	-0.07	-0.13	-0.28	-0.47
pt	bes	0.10*	0.19*	0.40*	0.72*
bes	pt	-0.02	-0.04	-0.08	-0.15

CHAPTER FOUR:

THE GREEK EXCEPTION: CHANGES IN DEFAULT RISK TRANSFER BETWEEN SOVEREIGN DEBTS AND FINANCIAL INSTITUTIONS DURING 'ATIPICAL' REGIMES

4. The Greek Exception: Changes in Default Risk Transfer between Sovereign Debts and Financial Institutions during 'Atypical' Regimes

4.1. Introduction

This study focuses on the relationship between default risk of sovereign debt and the debt of domestic financial institutions in Europe. It endogenously identifies *typical* and *atypical* regimes where these relationships differ, and whether the *atypical* regimes are prelude to financial crisis. Hansen and Seo's (2002) methodology is applied to identify a two regime threshold cointegration in bivariate vector error-correction (VEC) models of sovereign default risk and default risk of domestic financial institutions for Greece, Ireland, Italy, Portugal and Spain (GIIPS). The regime containing higher percentage of observations is defined as the *typical* regime, and the other one as the *atypical* regime. The aim is to understand how the default risk is transferred, if any, between the sovereign and domestic financial institutions in different regimes, i.e., *typical* and *atypical* regimes. The study also examines the dynamic short- and long-term interdependencies between the credit default swap (CDS) series of the sovereign debts and financial institutions in the two regimes by using impulse response functions (IRFs) from bivariate vector autoregressive (VAR) models as proposed by Alter and Schüler (2012). Daily CDS spreads are applied to capture default risk, and analyse the risk transfer between the sovereign debts and the domestic financial institutions in the GIIPS countries from June 2007 to July 2013.

The contribution of this chapter is twofold. First, the findings show that there exists a threshold effect in the cointegration relationship between the default swap rates of the sovereign and financial sectors. The *atypical* regimes identified are mainly located around the global credit crunch period (2007-2008) and the European sovereign debt crisis (Eurozone crisis since early 2010) for the GIIPS countries. The approach of detecting regime change is robust, since the regime shifts are suggested by data rather than by subjective time-period selections. Importantly, the findings indicate that the responses between the sovereign and the financial sectors change from one regime to the other. Previous research, Alter and Schüler (2012) for example, does not detect regime changes and find mixed results with their hypotheses.[11]

Second, in the typical regime for the countries except Greece, the results show that positive interdependencies exist between the default risk of the sovereign and financial sectors. Specifically, a shock in the sovereign daily CDS spread of a country is followed by increases in the daily CDS spread of the financial institutions in that country, and vice versa. Importantly, in the atypical regime, the impacts magnitude in positive interdependencies between the default risk of the public and financial sectors are generally much larger than that in the typical regime. This is consistent with the intuition that during the credit crunch and the Eurozone crisis periods, the financial sectors are more sensitive to the credit health of their governments. A decline in the default risk of the financial sector often leads to declines in the sovereign CDS spreads. The sensitivity of the sovereign default risk to the financial institutions' default risk is also increased.

In a sharp contrast, the interdependent relationship between the sovereign and financial sectors is different for Greece. In the typical regime, only the impacts of sovereign default risk on the default risk of the domestic financial sector are positively significant, the impacts of the other way are insignificant. In the atypical regime for Greece however, the impacts of the sovereign default risk on the default risk of the financial institutions are reduced to either zero or negative. More importantly, the default risk of the financial sector exhibits strong and negative impacts on the sovereign default risk during the credit crunch or the Eurozone crisis.

[11] It is important to note that setting sample sub-periods by events is different from the approach identifying structural breaks.

The remaining part of this study is organised as follows. Section 4.2 explains the mechanism of risk transfer between the sovereign and banking sectors. Section 4.3 is the data description. Section 4.4 explains the estimation methodology. Section 4.5 analyses the results. Section 4.6 concludes.

4.2. Mechanism of Risk Transfer

When a country faces financial distress, for example, high public deficit or heavy debt burdens, the sovereign default risk of this country raises and the sovereign debt devalues. In the short run, (i) for the domestic financial institutions the cost of holding the sovereign debt is higher, which changes the balance sheet of the financial institutions; (ii) for other governments that support the financially distressed country by providing bailout packages, the sovereign and financial sectors of the supporting countries also faces higher default risk for holding the devaluated sovereign debt. The financial systemic risk, which is the impacts of macroeconomic factors on banking credit risk, is pro-cyclical with the business cycle or macroeconomic environment (Borio *et al*. (2002), Marcucci and Quagliariello (2009) and Festic *et al*. (2011)). In the long run, sovereign debt crises are followed by reduction in foreign capital inflows as investors' awareness to the sovereign default risk increase, and the domestic credit becomes more expensive, which negatively affect the domestic economy and hence increase the default risk of the domestic financial institutions.

When a financial institution faces financial distress, the default risk of the financial institution is higher. This increases the probability that it cannot fulfil the obligations to other financial counterparties, thus the financial counterparties could face funding difficulties, and their default risk is higher. Thereafter, a systemic financial crisis might arise and hamper the whole economy, which also deteriorate public finances, thus the sovereign default risk is higher.

Acharya *et al*. (2011) document a "two-way feedback" effect between the financial sector and the sovereign sector, suggesting positive interdependences between the default risks of the two sectors. In the research the results also show that, in general for all the countries except Greece in the atypical regime, the responses of sovereign default risk to the shocks in the financial sectors are positive, and vice versa.

In the atypical regime such as during the global credit crunch period (2007-2008) or the Eurozone crisis (since 2010), it is expected that in general, responses between the default risk of the public and financial sectors are stronger than that in the typical regime.

During financial crises, government guarantees to the financial sector increase, thus changes in the sovereign default risk have direct impact on the perceived default risk of the financial sector. Also because the financial institutions may receive rescue capital from their governments, the financial sector is more sensitive to the credit health of their governments. Hence, the sensitivity of the financial institutions' default risk to the sovereign default risk is expected to increase.

The impacts of the financial sector on the government sector are divided into two ways. On one hand, a decline in the default risk of the financial sector results in healthier economy and improve the public finances, which decreases the default risk of the sovereign debts. On the other hand, when the government takes over the debt burdens of the financial sector, the default risk declined in the financial sector is directly transferred to the government, indicating the relieved default risk of the financial institutions leads to higher probability of government default in the future. The overall impact of the default risk of the financial sector on the sovereign default risk depends on which force is stronger.

Thus it expected that the outcome of the private-to-public risk transfer in the atypical regime is heterogeneous among the GIIPS countries. Dieckmann and Plank (2012) report that the states of the financial system at the beginning of the financial crisis have strong explanatory power for the private-to-public risk transfer, and that an Economic and Monetary Union (EMU) member is more sensitive to the health of its pre-crisis financial system. So for example in Greece, before and at the beginning of the credit crunch period, the government debt is already relatively high. In the later Eurozone crisis, the Greek government has to issue more sovereign debts to relieve the stress in the domestic financial sector, thus the sensitivity of the sovereign default risk to a shock in the domestic financial sector is exaggerated.

4.3. Data Description

The study uses CDS spreads to capture credit default risk of an institution, or the government. Studies have shown that CDS spreads can measure investors' risk preference. According to Hull *et al*. (2004), both changes and levels of CDS spread contain significant information in estimating the probability of rating events, but CDS spread changes conditional on rating events, and downgrade announcement and negative outlooks do not have helpful information. Ismailescu and Kazemi (2010) analyse the relationship between the sovereign CDS spreads and the sovereign credit ratings, and show that investors can make decisions according to the same public information that would lead to the changes in CDS spreads prior to a rating announcement. Düllmann and Sosinska (2007) analyse the CDS spreads of banks, and document that banks' CDS spreads indicate banking credit risk from three risk sources including idiosyncratic risk, systematic risk and liquidity risk.

Daily data of CDS spreads is collected from DataStream. The selection of financial institution and sovereign CDS series was restricted by data availability. The study analyses 5 Eurozone countries, including Greece (GR), Ireland (IE), Italy (IT), Portugal (PT), and Spain (ES) (see Panel A of Appendix 11), together with their domestic financial institutions (19 financial institutions in total, see Panel B of Appendix 11). These countries have requested for the bailout funding from the European Financial Stability Facility (EFSF) or have been facing severe default risk during the Eurozone crisis. The CDS series of the financial institutions are chosen according to the Standard Industrial Classification (SIC) code of the institutions (major groups 60-67, including Finance, Insurance, and Real Estates), respectively.

The study use five-year CDS, since it is the largest and the most liquid constituent of the CDS markets. The restructuring types for the sovereign CDS series are all Complete Restructuring (CR), as it is the only restructuring clause applied by the sovereign CDS series. The restructuring types for the financial institutions are all "Modified-Modified" (MM) Restructuring. The former restructuring clause, Modified Restructuring (MR), had been too severe in its limitation of 60-month deliverable obligations, and the MM restructuring clause has been introduced and applied by the European market participants since 2003.

The data set starts from 29 June 2007 until 31 July 2013. The Greek CDS series stops on 8 March 2012, after Greek debt restructuring triggered approximately $3.2bn CDS credit protection payouts on Greek sovereign debt. Particularly, the CDS series of National Bank of Greece (*nbg*) starts from 18 November 2008, and the CDS series of Allied Irish Bank (*aib*) ends on 27 April 2011 due to data availability.

[Insert Figure 4.1]

Figure 4.1 shows the sovereign CDS spreads for each of the GIIPS countries in the sample. The EFSF bailouts during the Eurozone crisis for Greece (Greek first bailout (1) and second bailout (4)), Ireland (2) and Portugal (3) are displayed. Before February 2010, the sovereign CDS spreads of all the countries remain low and stable.

The sovereign CDS spreads of the GIIPS countries continue to increase after the Greek first bailout. But since the second Greek bailout, except the Greek sovereign CDS spreads remaining high, the sovereign CDS spreads of the other four countries have started to come down.

[Insert Table 4.1]

Table 4.1 reports summary statistics of the CDS spreads of the GIIPS countries. The maximum values of the Greek CDS series are generally much larger than the CDS series in other countries, and the standard deviations are also larger, indicating the short-run default risk transfer in Greece might be different from that in other countries.

4.4. Estimation Methodology

This part first explains the model by Hansen and Seo (2002), which is used in the research to define regimes for the whole dataset. Next the impulse response functions (IRFs) of the two regimes are applied to examine the dynamic short- and long-run interdependency of the sovereign and financial institution CDS series.

4.4.1. Determining Typical and Atypical Regimes

The study carries out the impulse response functions (IRFs) analysis of the bivariate vector autoregressive (VAR) model in two regimes: typical and atypical regimes. Prior to the dynamic short- and long-run analyses, the model by Hansen and Seo (2002) is applied to test for the two-regime threshold cointegration in the bivariate vector error-correction (VEC) model.

Let x_t be a p-dimensional $I(1)$ time series which is cointegrated with one 2×1

cointegrating vector β. Let $w_t(\beta) = \beta' x_t$ denote the $I(0)$ error-correction term. A bivariate VECM of order $l+1$ can be compactly written as

$$\Delta x_t = A' X_{t-1}(\beta) + u_t, \tag{4.1}$$

where

$$X_{t-1}(\beta) = \begin{pmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \Delta x_{t-2} \\ \vdots \\ \Delta x_{t-l} \end{pmatrix}.$$

As an extension of model (1), the two-regime threshold cointegration model by Hansen and Seo (2002) takes the form

$$\Delta x_t = \begin{cases} A_1' X_{t-1}(\beta) + u_t & if \;\; w_{t-1}(\beta) \le \gamma, \\ A_2' X_{t-1}(\beta) + u_t & if \;\; w_{t-1}(\beta) > \gamma, \end{cases}$$

where γ is the threshold parameter. The model uses maximum likelihood estimation of the complete threshold cointegration, and applies a SupLM test for the threshold. The threshold model has two regimes, which examines the structural changes in unknown cointegration with a threshold effect. Let $cds_{Sov,t}$ be the sovereign CDS spreads in log-level (in short '*Sov*'), and $cds_{Fi,t}$ be the CDS spreads in log-level of a domestic financial institution (in short '*Fi*') at day *t*. The following bivariate VAR and VEC models are estimated:

$$\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{l+1} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t , \tag{4.2}$$

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \mu + \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t . \tag{4.3}$$

where $w_{t-1} = cds_{Sov,t-1} + \beta cds_{Fi,t-1}$, which is the estimated cointegrating relationship between the two CDS series. v and μ are vectors of constants. A VEC model with (p-1) lags can be converted to a VAR structure with p lags, i.e., eq. (4.2) is equal to eq. (4.3). A VEC model is able to capture the long-run relationship which indicated by the α and the $ß$ coefficients. When the threshold condition $w_{t-1}(\beta) \leq or > \gamma$ (e.g. γ = -1.001) is found, it means the cointegrating relationship in the long run is $w_{t-1} = cds_{Sov,t-1} + \beta cds_{Fi,t-1} \leq or > -1.001$ in different regimes. The value of γ is different for different pairs of variables, as $(\hat{\beta}, \hat{\gamma})$ is picked according to the model to minimise the likelihood function (Hansen and Seo (2002)). After the threshold is estimated and conditioned, the regime with smaller α coefficients and higher percentage of observations is defined as 'typical' regime which has minimal error-corrections effects and minimal dynamics, and the other one as the 'atypical' regime. In the atypical regime the two series deviate more from the long-term cointegration, and the force correcting both variables back towards their long-run equilibrium is stronger.

[Insert Table 4.2, 4.3 and 4.4]

Tables 4.2, 4.3 and 4.4 show the cointegration results of the linear VEC model without threshold, typical regime and atypical regime, respectively. For exposition purpose, the example takes gr (Greek sovereign debt) and aca (Alpha Bank) log-CDS series (see Table 4.2, 4.3 and 4.4). The estimated VEC without a threshold effect is given below

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.00)}{0.011} + \underset{(0.00)}{0.002} w_{t-1} + \underset{(0.04)}{0.127} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.012} \Delta cds_{Fi,t-1} + u_{1t}, \\ \Delta cds_{Fi,t} = \underset{(0.00)}{0.019} + \underset{(0.00)}{0.006} w_{t-1} + \underset{(0.04)}{0.035} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.017} \Delta cds_{Fi,t-1} + u_{2t}, \end{cases}$$

where the cointegrating relationship is $cds_{Sov,t} = 1.418 cds_{Fi.t} - 0.235$. Then the model by Hansen and Seo (2002) is used, the estimated cointegration is $w_t = cds_{Sov,t} - 1.451 cds_{Fi.t}$, and the estimated threshold is -1.001 (the *p*-values of the α_{Sov} coefficients suggests the significance of the threshold cointegration).

The estimated threshold VEC is shown below:

Typical regime

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.01)}{0.021} + \underset{(0.00)}{0.005} w_{t-1} + \underset{(0.04)}{0.105} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.009} \Delta cds_{Fi,t-1} + u_{1t}, \\ \Delta cds_{Fi,t} = \underset{(0.01)}{0.011} + \underset{(0.00)}{0.003} w_{t-1} + \underset{(0.02)}{0.042} \Delta cds_{Sov,t-1} - \underset{(0.02)}{0.018} \Delta cds_{Fi,t-1} + u_{2t}, \end{cases} \quad w_{t-1} \le -1.001,$$

Atypical regime

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.02)}{-0.015} - \underset{(0.02)}{0.019} w_{t-1} + \underset{(0.08)}{0.500} \Delta cds_{Sov,t-1} - \underset{(14.01)}{41.752} \Delta cds_{Fi,t-1} + u_{1t}, \\ \Delta cds_{Fi,t} = \underset{(0.21)}{-0.218} - \underset{(0.32)}{0.332} w_{t-1} - \underset{(0.20)}{0.102} \Delta cds_{Sov,t-1} - \underset{(46.60)}{39.964} \Delta cds_{Fi,t-1} + u_{2t}, \end{cases} \quad w_{t-1} > -1.001.$$

Thus relatively usual regime occurs when $cds_{Sov,t} \leq 1.451 cds_{Fi.t} - 1.001$, with 94% of the observations in this regime, and this is defined as the 'typical' regime. The other regime (with 6% of the observations) is defined as the 'atypical' regime when $cds_{Sov,t} > 1.451 cds_{Fi.t} - 1.001$. The threshold condition is the same for the typical and the atypical regimes ($w_{t-1}(\beta) \leq or > \gamma$), however as the α coefficients are not the same for the different regimes, the cointegrating vectors are different for the typical and the atypical regimes.

4.4.2. Impulse Response Functions (IRFs) or VAR Model

After determination of the typical and atypical regimes according to the threshold condition estimated in the threshold cointegration, the impulse response functions (IRFs) of the VAR model (4.2) is estimated using CDS spreads in log-levels, and noted that a VEC model with (*p*-1) lags can be represented as a VAR structure with *p* lags. Impulse response functions (IRFs) are used to depict the impacts of one-time shock to a variable within one standard deviation not only on itself but also on other endogenous variables of current and future periods; in other words, IRFs trace the reactions of endogenous variables according to the changes of other exogenous variables in different periods. The variables generated (innovations or impulses) are correlated according to the above correlations of residuals for the bivariate VAR models, and these innovations ought to be orthogonalised.

4.5. Empirical Findings

4.5.1. Cointegration in Typical and Atypical Regimes

This section uses the model by Hansen and Seo (2002) (as described in Section 4.4.1) to detect typical and atypical regimes and to test for cointegrating relationship between the default risk of the sovereign debts and financial institutions. The analysis continues with the example of gr (Greek sovereign debt) and aca (Alpha Bank) log-CDS series (see Tables 4.2, 4.3 and 4.4).

The estimated threshold VEC is shown below:

Typical regime

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.01)}{0.021} + \underset{(0.00)}{0.005} w_{t-1} + \underset{(0.04)}{0.105} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.009} \Delta cds_{Fi,t-1} + u_{1t}, \\ \Delta cds_{Fi,t} = \underset{(0.01)}{0.011} + \underset{(0.00)}{0.003} w_{t-1} + \underset{(0.02)}{0.042} \Delta cds_{Sov,t-1} - \underset{(0.02)}{0.018} \Delta cds_{Fi,t-1} + u_{2t}, \end{cases} \quad w_{t-1} \le -1.001,$$

Atypical regime

$$\begin{cases} \Delta cds_{Sov,t} = -\underset{(0.02)}{0.015} - \underset{(0.02)}{0.019} w_{t-1} + \underset{(0.08)}{0.500} \Delta cds_{Sov,t-1} - \underset{(14.01)}{41.752} \Delta cds_{Fi,t-1} + u_{1t}, \\ \Delta cds_{Fi,t} = -\underset{(0.21)}{0.218} - \underset{(0.32)}{0.332} w_{t-1} - \underset{(0.20)}{0.102} \Delta cds_{Sov,t-1} - \underset{(46.60)}{39.964} \Delta cds_{Fi,t-1} + u_{2t}, \end{cases} \quad w_{t-1} > -1.001.$$

The coefficient of $\Delta cds_{Sov,t}$ in the atypical regime is 0.500, which is much larger than the coefficient in the typical regime (0.105). The other coefficients of $\Delta cds_{Sov,t}$

and $\Delta cds_{Fi,t}$ in the atypical regime are insignificant in this case, but comparing the results of Table 4.3 and 4.4, the findings indicate that in general the absolute values of the coefficients of $\Delta cds_{Sov,t}$ and $\Delta cds_{Fi,t}$ in the atypical regime are much larger than those in the typical regime. The estimated results indicate that in the typical regime, $\Delta cds_{Sov,t}$ and $\Delta cds_{Fi,t}$ have minimal error-correction effects and minimal dynamics, and in the atypical regime, the error-correction effect is stronger.

Figures 4.2-4.6 visually show the CDS spreads of sovereign debts and financial institution in the GIIPS countries, respectively, and typical and atypical regimes suggested by the estimated threshold VEC model. For example, Figure 4.2 shows the co-movements of CDS spreads of Greek sovereign debt and Alpha Bank. The grey parts indicate the typical regime, and the white parts (in early 2008 and March 2012) show the atypical regime of the two CDS series. The four vertical lines indicate the four bailouts issued to Greece (two bailouts), Ireland and Portugal by the European Financial Stability Facility (EFSF) during the Eurozone crisis. The findings show that the atypical regime usually happens when the co-moving trend of the bi-variables changes, indicating the cointegration relationship between the bi-variables changes. Moreover, the atypical regime is mainly located around the global credit crunch period (2007-2008) and the Eurozone crisis.

[Insert Figures 4.2-4.6]

The concept of 'regime shifts' in this chapter is different from the 'structural breaks' in Chapter 3. In Chapter 3, hypothesis is made that there is a structural break in the intercept or the slope for each pair of variables for the whole time period, and most breakpoints detected are closed to certain bailout events, then the bailout events are used as breakpoints in order to examine the changes in the default risk transfer. However, in this chapter, the method is to use a threshold condition for the whole time periods that covers all the financial crises and those bailout events, so it is not contrary to have breaks in certain regime. Further comparison is made for Figures 4.2-4.6 to the breakpoint dates in Table 3.2, and most breakpoints are exactly the time when regime shifts.

4.5.2. Default Risk Transfer in Typical and Atypical Regimes

After displaying the typical and atypical regimes of each pair of bi-variables, this part analyses the results of impulse responses of all the GIIPS countries in different regimes. Table 4.5 shows the impulse responses of the five countries in the two regimes. The responses after 1, 2, and 5 days represent the short-term effect, and the responses after 22 days show the long-run effect. For example, in the typical regime, the responses of *aca* to the impulse in *gr* after 1, 2 and 5 days are 0.04, 0.06 and 0.09, respectively, and the response after 22 days is 0.27. The responses of *gr* to the impulse in *aca* after 1, 2 and 5 days are -0.01, -0.02 and -0.04, respectively, and the response after 22 days is -0.11.

[Insert Table 4.5]

It is observed that, in the typical regime for the countries except Greece, a two-way feedback effect exists between the default risk of the sovereign and financial sectors, as most of the responses of financial institutions to the sovereign CDS shocks are significantly positive, and vice versa, in both the short and long run. Importantly, in the atypical regime, it is found that while the positive interdependencies between the sovereign and financial sectors remain significant, the responses to the changes in the impulse variables become much larger generally than that in the typical regime. Such results indicate as explained in Section 4.2 that the sensitively of the financial institutions' default risk to the sovereign default risk increase for these countries, and vice versa.

Comparing the results of Greece with other countries, the results show that the interdependent relationship between the sovereign and financial sectors is different. In the typical regime, only the impacts of sovereign default risk on the default risk of the domestic financial sector are positively significant, and the impacts of the other way are insignificant. In the atypical regime for Greece, the impacts of the sovereign default risk on the default risk of the financial institutions are reduced to either zero or negative. In a shock contrast, the sovereign default risk exhibits strong and negative responses to the shock in the default risk of the financial institutions, for example, in the atypical regime, the responses of *gr* to the impulse in *aca* after 1, 2 and 5 days are -34.99, -33.03 and -24.83, respectively. Such heterogeneous results in Greece indicate that in the atypical regime the negative force of the impact of the financial sector on the sovereign default risk is much stronger than the positive force. This is because that the state of the financial system of a country since the beginning of the financial crisis has strong explanatory power for the private-to-public risk transfer. For Greece, as the government debt has been already relatively high before and at the beginning of the credit crunch period, the sensitivity of the sovereign default risk to a shock in the domestic financial sector is exaggerated when Greece has to issue more sovereign debt in later crisis.

The graphs of impulse responses between each pair of variables in the GIIPS countries (see Appendices 12-16) show the results more clearly, that in the atypical regime, except Greece, the responses of the sovereign default risks to their financial institutions are larger than that in the typical regime, and vice versa. For Greece, however, in the atypical regime, the responses of the sovereign default risks to their financial institutions are significantly negative.

4.6. Conclusion

This chapter applies the bivariate VEC model with a threshold effect to test the cointegration of the default risk of the sovereign and financial sectors for the GIIPS countries in two regimes, i.e., typical and atypical regimes. The findings show that this model is able to detect regime shifts in the cointegration relationship between the sovereign and the financial sectors, and the atypical regimes is mainly found around the global credit crunch period (2007-2008) and the Eurozone crisis (since early 2010).

The study further analyse the impulse responses between the sovereign default risk and the default risk of the financial institutions in the typical and atypical regimes. The results indicate that for the countries except Greece, positive interdependencies exist between the default risk of the sovereign and financial sectors. Importantly, the positive responses between the two sectors become stronger in the atypical regime, which implies that the sensitivity of the sovereign default risk to the default risk of the financial institutions is higher, and vice versa. For Greece, however, the results indicate that in the typical regime, only the impacts of the sovereign default risk on the default risk of the domestic financial sectors are positively significant. In the atypical regime, the public-to-private impacts become insignificant, and more importantly, the default risk of the financial institutions has negatively significant impact on the sovereign default risk. The implication of the findings is that the different pattern of the results across countries is due to the financial situation of the countries at the beginning of the financial crisis. For Greece, since the negative force is stronger than the positive force in the default risk transfer from the financial sector to the sovereign sector in the atypical regime, the overall sensitivity of the sovereign default risk to a shock in the financial institutions is negative.

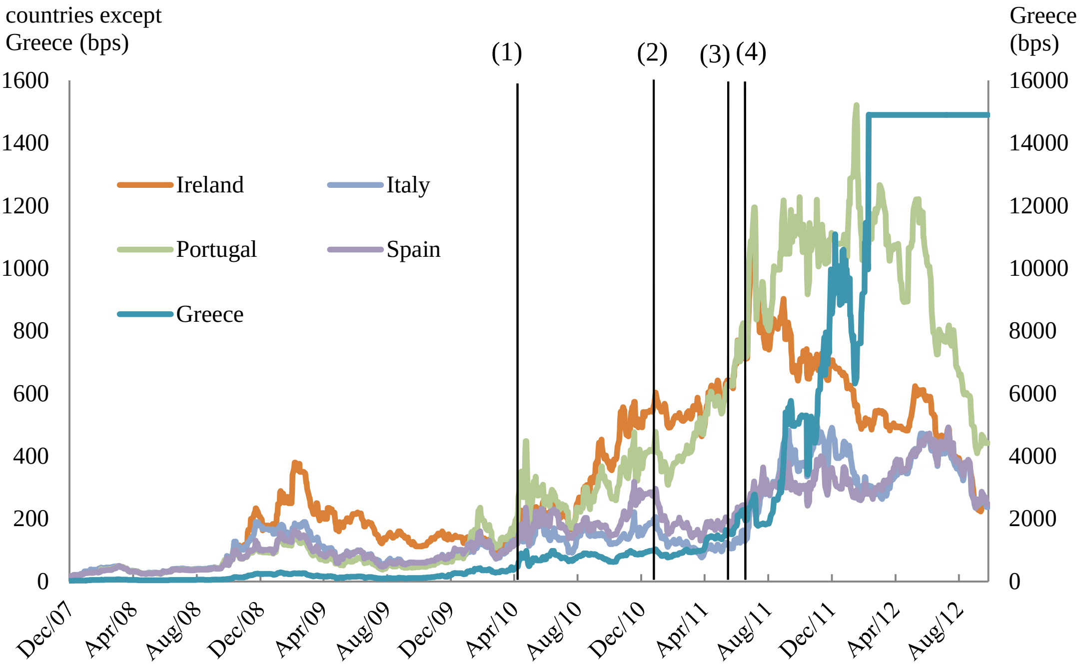


Figure 4.1. Sovereign CDS Spreads for GIIPS Countries

The Figure plots the sovereign CDS spreads for the GIIPS countries. Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as periods 1, 2, 3 and 4 as follows. The Greek first bailout issued by the EFSF is on 9 May 2010 (1), and the Greece officially requested for the second bailout on 21 July 2011 (4). The settlement date of the tranche of the Irish bailout by the EFSF is on 25 January 2011 **(**2), and the settlement date of the tranche of the Portugal bailout is on 15 June 2011 (3). The Greek sovereign CDS spreads has remained unchanged, since Greek debt restructuring triggered approximately \$3.2bn CDS credit protection payouts on Greek sovereign debt in early March 2012.

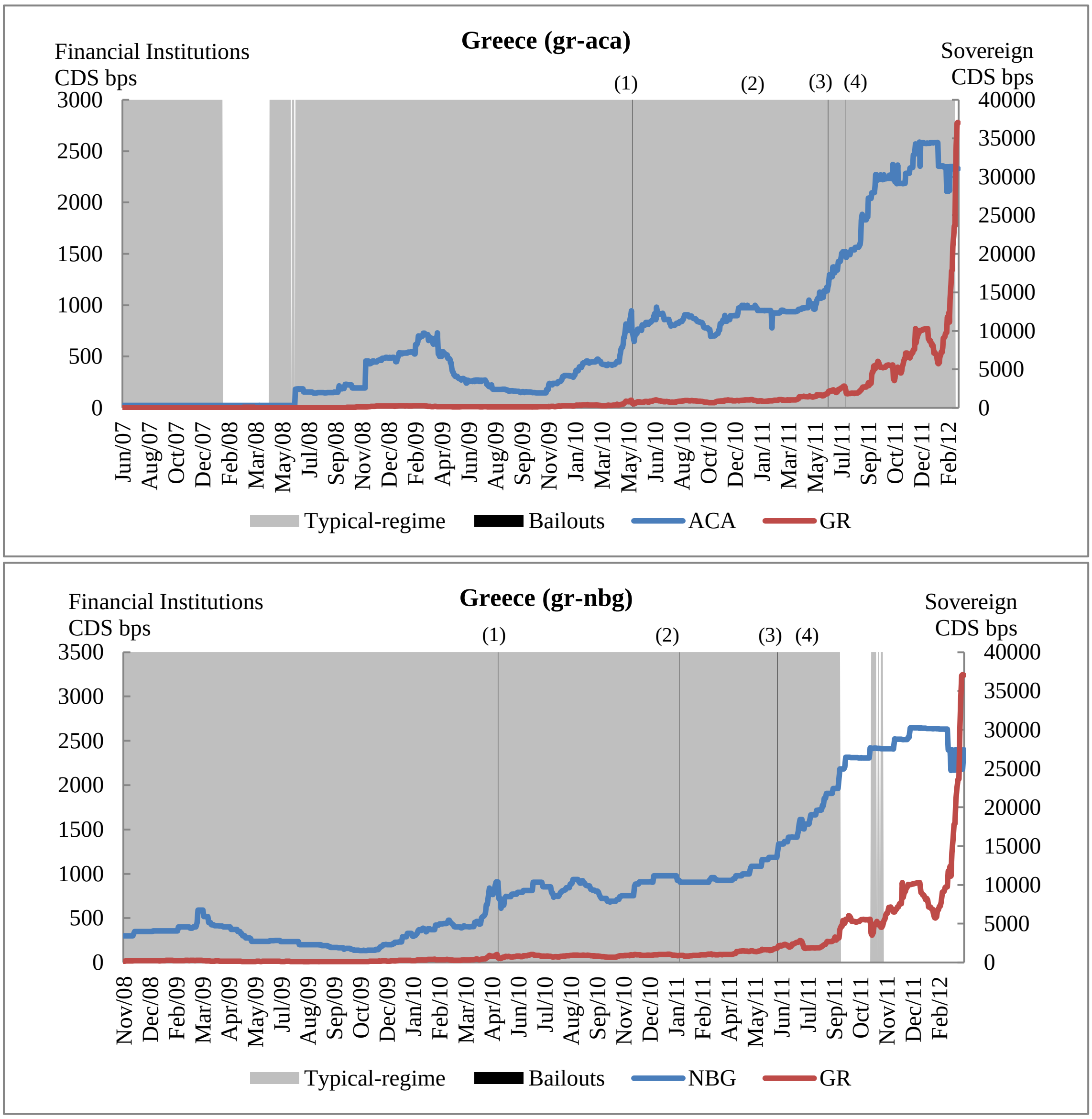


Figure 4.2. CDS Spreads of Sovereign Debt and Financial Institutions in Typical and Atypical Regimes for Greece

Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as periods 1, 2, 3 and 4 as follows. The Greek first bailout issued by the EFSF is on 9 May 2010 (1), and the Greece officially requested for the second bailout on 21 July 2011 (4). The settlement date of the tranche of the Irish bailout by the EFSF is on 25 January 2011 **(**2), and the settlement date of the tranche of the Portugal bailout is on 15 June 2011 (3). The Greek sovereign CDS spreads has remained unchanged, since Greek debt restructuring triggered approximately $3.2bn CDS credit protection payouts on Greek sovereign debt in early March 2012. The grey parts indicate the typical regime, and the white parts show the atypical regime.

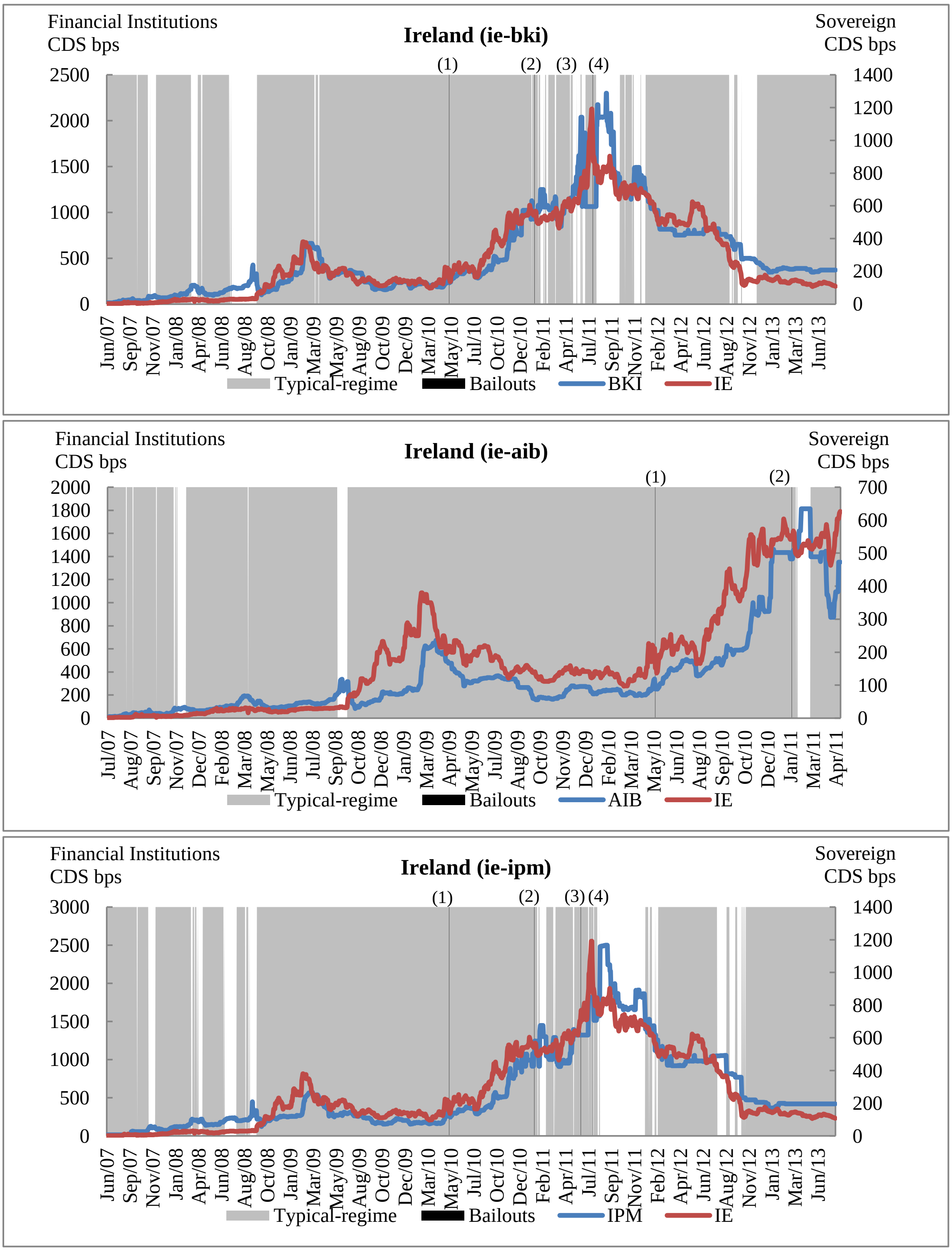
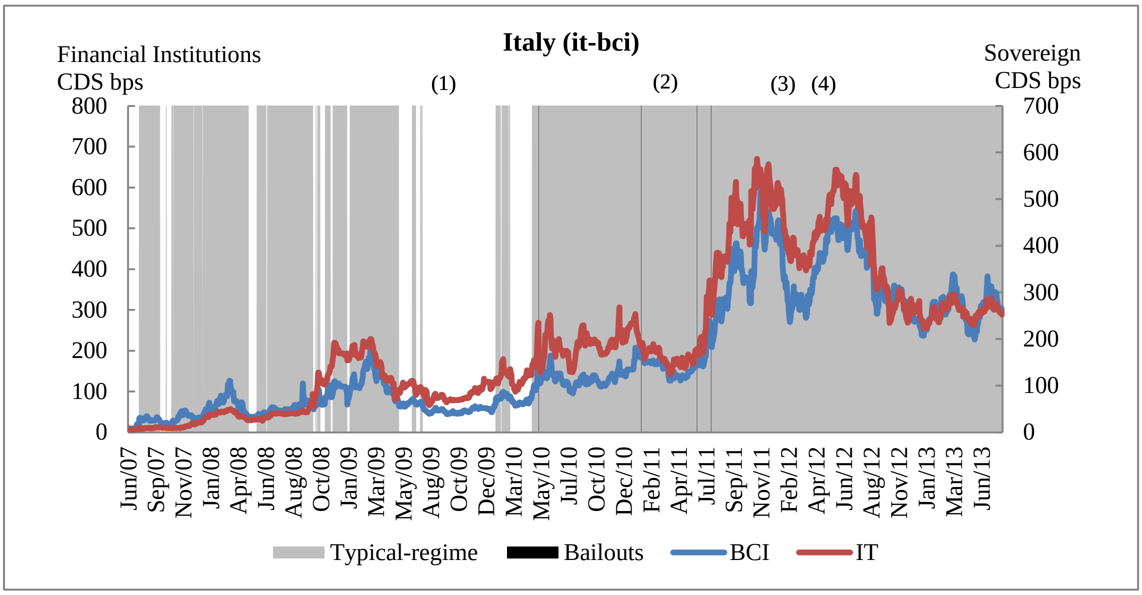


Figure 4.3. CDS Spreads of Sovereign Debt and Financial Institutions in Typical and Atypical Regimes for Ireland

Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as periods 1, 2, 3 and 4 as follows. The Greek first bailout issued by the EFSF is on 9 May 2010 (1), and the Greece officially requested for the second bailout on 21 July 2011 (4). The settlement date of the tranche of the Irish bailout by the EFSF is on 25 January 2011 **(**2), and the settlement date of the tranche of the Portugal bailout is on 15 June 2011 (3). The grey parts indicate the typical regime, and the white parts show the atypical regime.



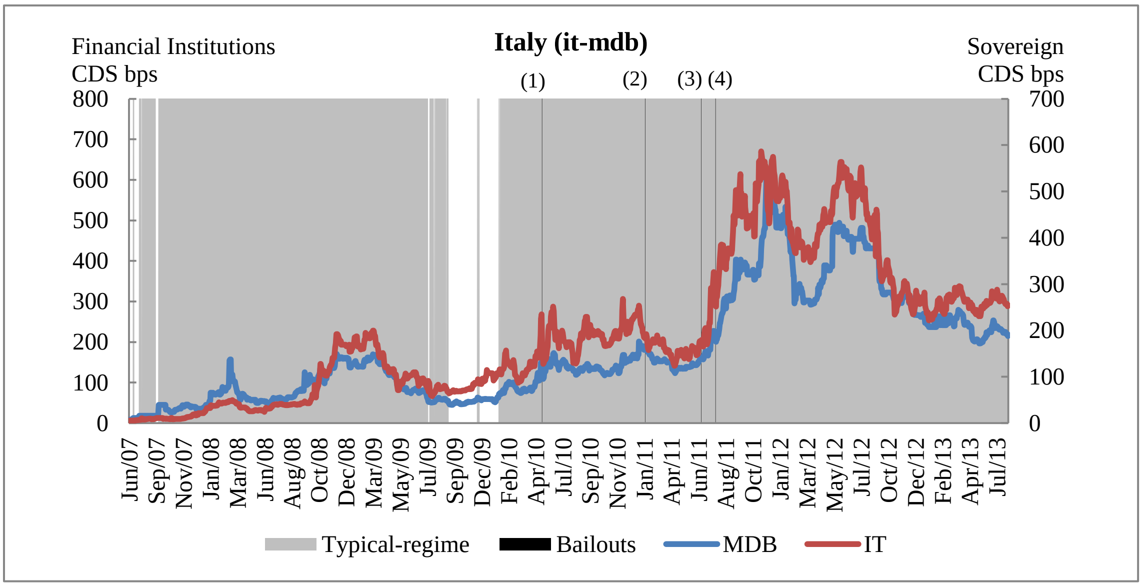
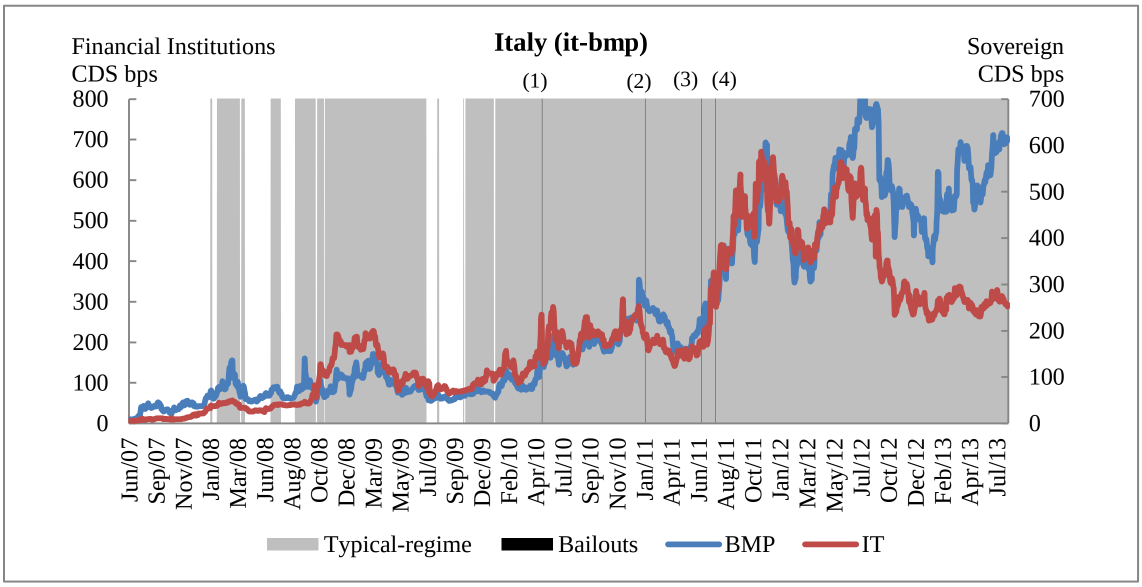
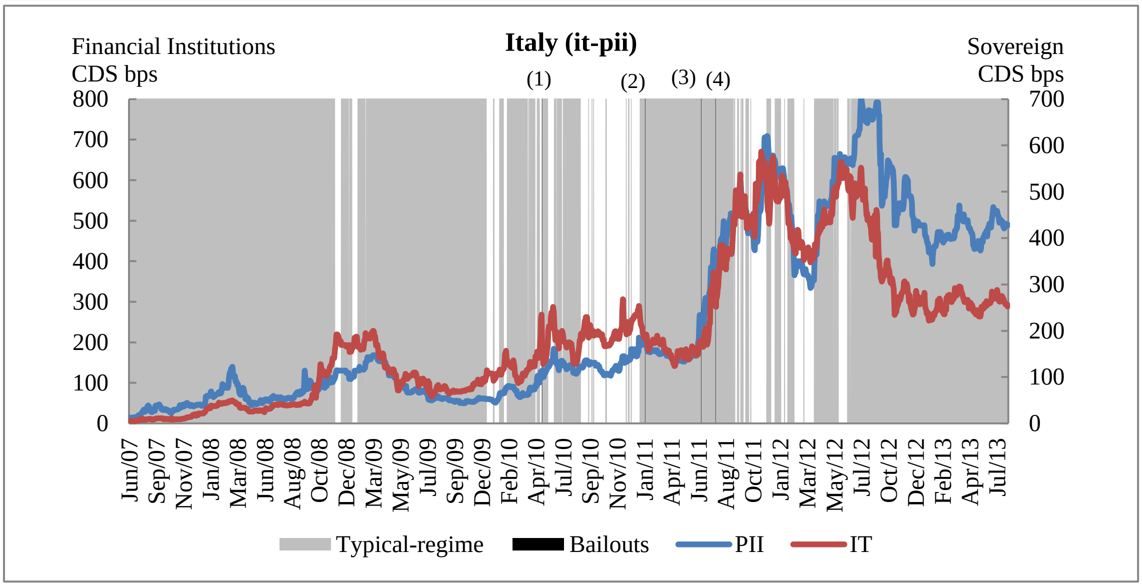


Figure 4.4. CDS Spreads of Sovereign Debt and Financial Institutions in Typical and Atypical Regimes for Italy

Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as periods 1, 2, 3 and 4 as follows. The Greek first bailout issued by the EFSF is on 9 May 2010 (1), and the Greece officially requested for the second bailout on 21 July 2011 (4). The settlement date of the tranche of the Irish bailout by the EFSF is on 25 January 2011 (2), and the settlement date of the tranche of the Portugal bailout is on 15 June 2011 (3). The grey parts indicate the typical regime, and the white parts show the atypical regime.





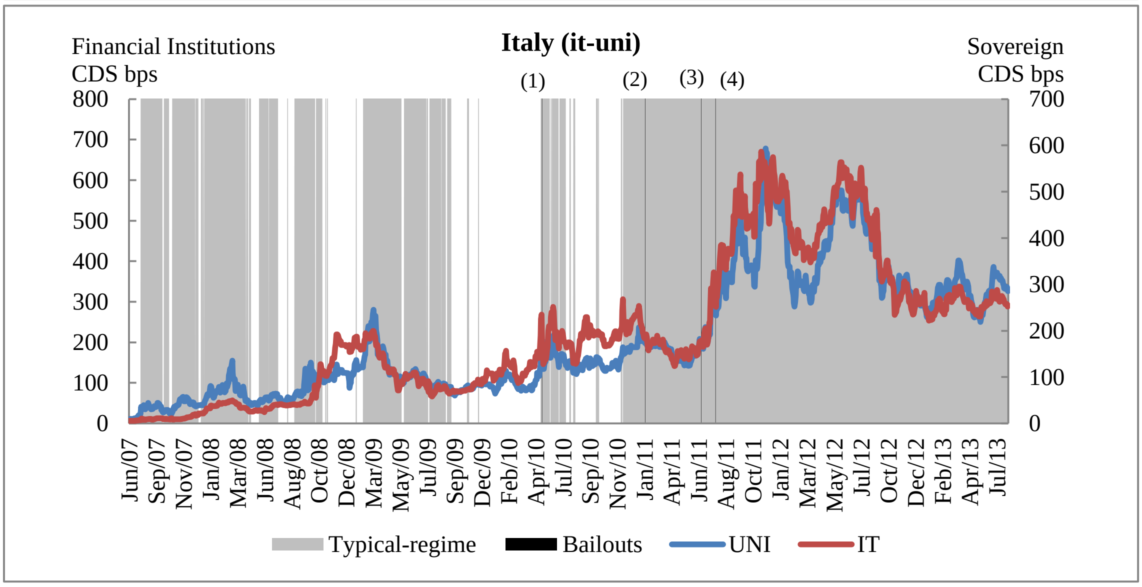
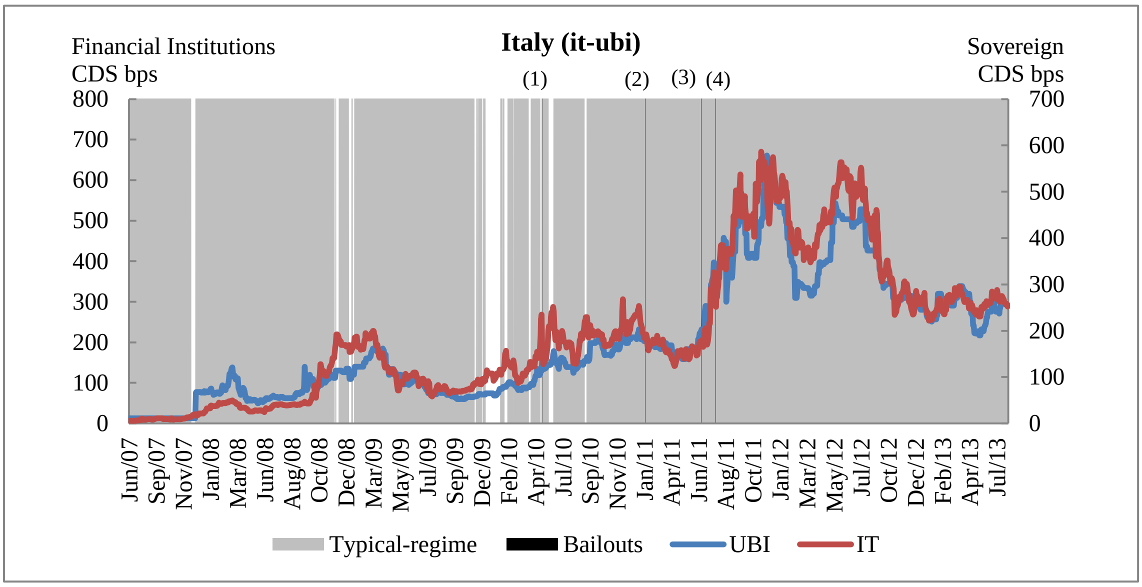


Figure 4.4 *(continued)*



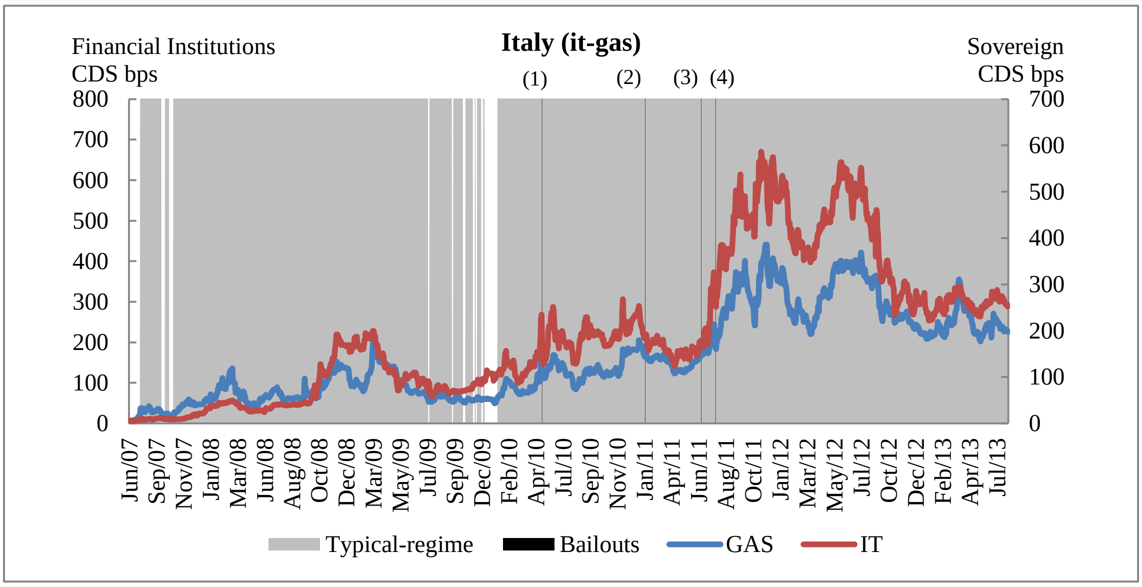
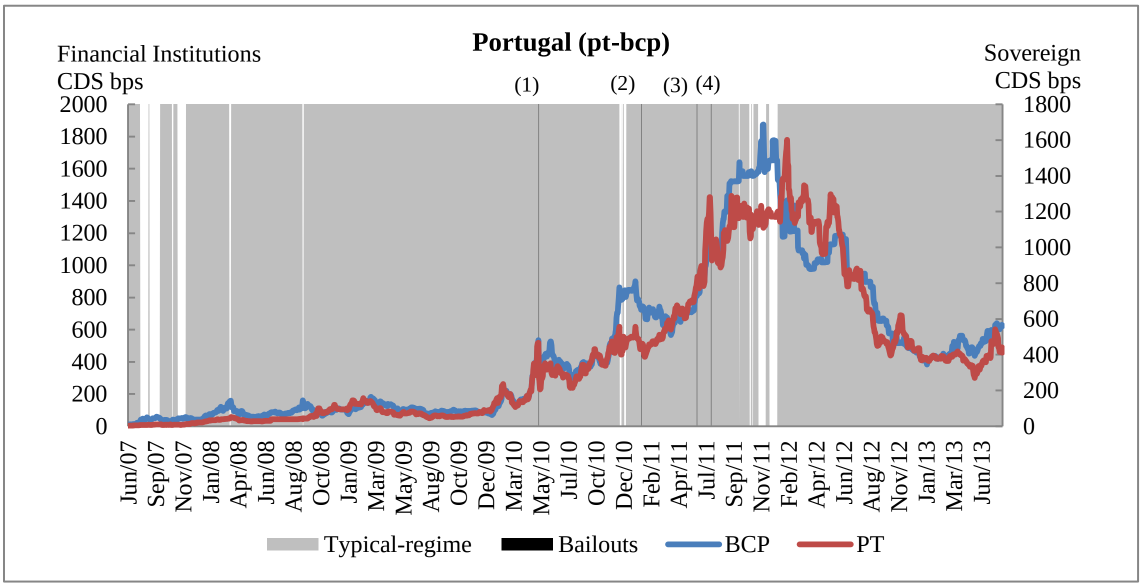


Figure 4.4 *(continued)*



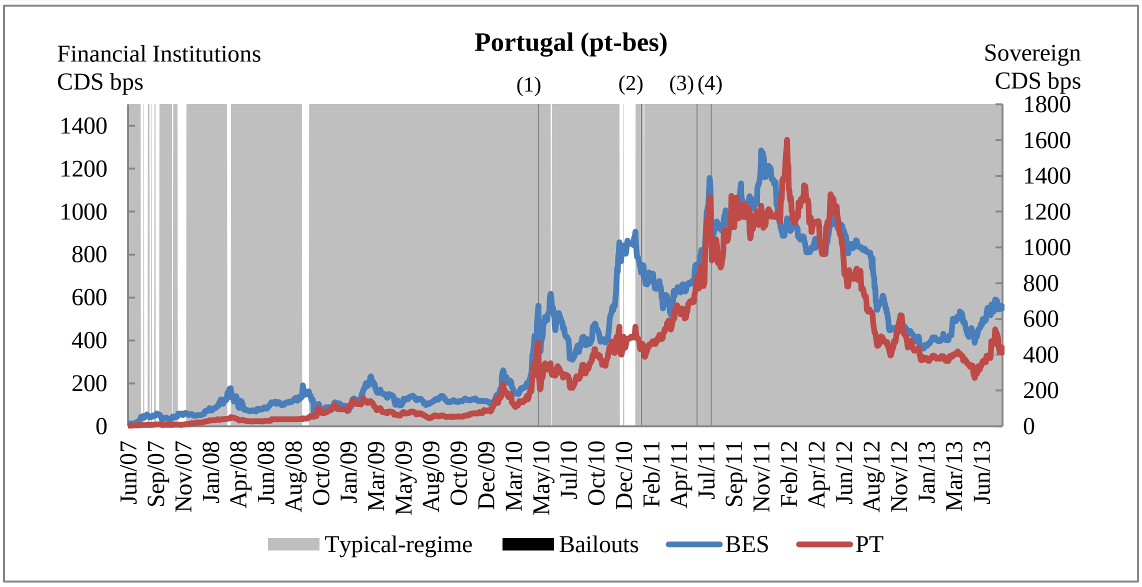


Figure 4.5. CDS Spreads of Sovereign Debt and Financial Institutions in Typical and Atypical Regimes for Portugal

Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as periods 1, 2, 3 and 4 as follows. The Greek first bailout issued by the EFSF is on 9 May 2010 (1), and the Greece officially requested for the second bailout on 21 July 2011 (4). The settlement date of the tranche of the Irish bailout by the EFSF is on 25 January 2011 (2), and the settlement date of the tranche of the Portugal bailout is on 15 June 2011 (3). The grey parts indicate the typical regime, and the white parts show the atypical regime.

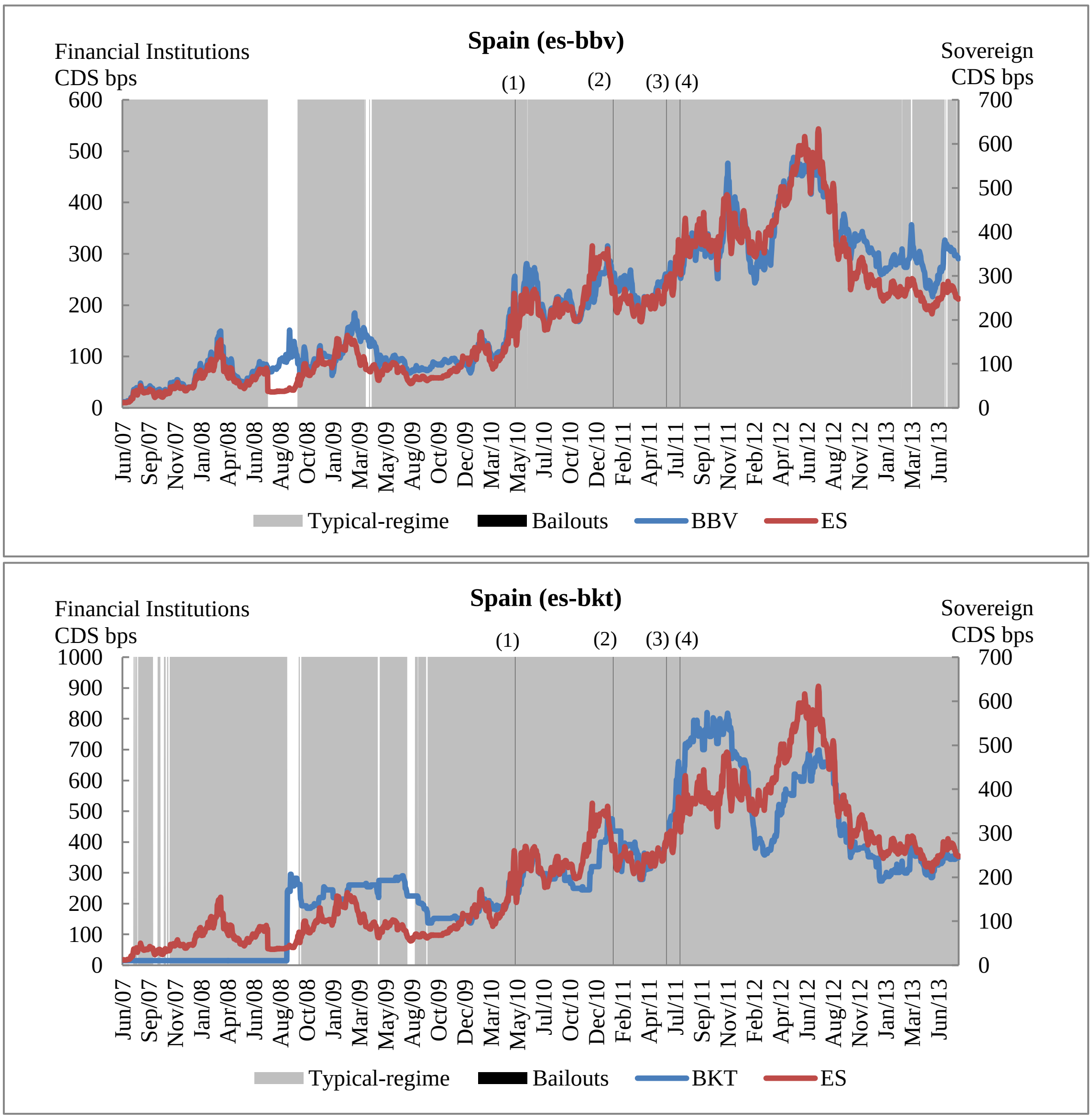
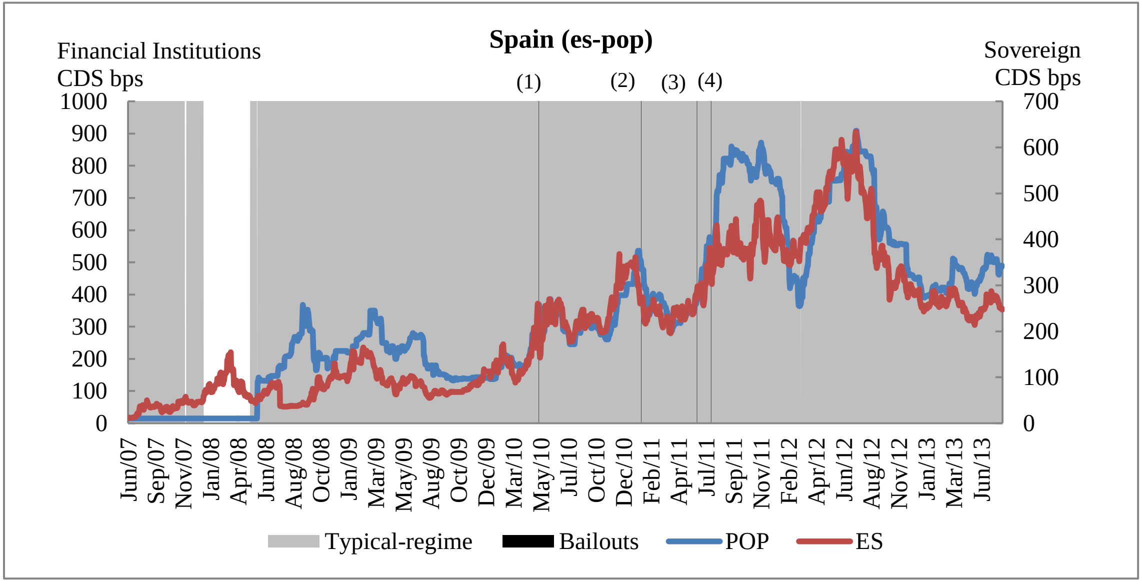
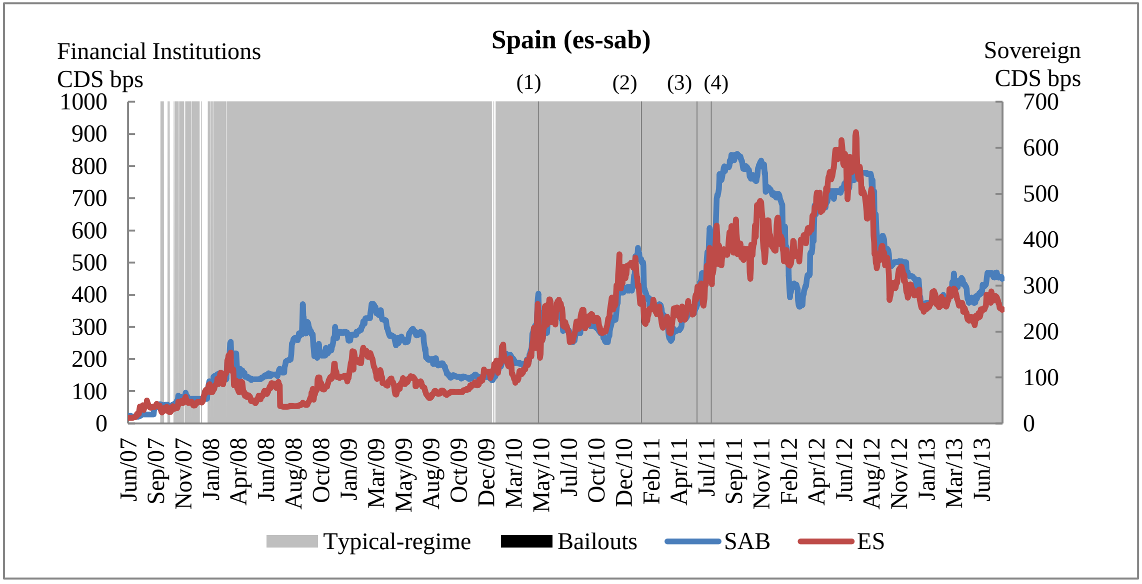


Figure 4.6. CDS Spreads of Sovereign Debt and Financial Institutions in Typical and Atypical Regimes for Spain

Four settlement dates of bailouts by the EFSF to Greece, Ireland and Portugal are denoted as periods 1, 2, 3 and 4 as follows. The Greek first bailout issued by the EFSF is on 9 May 2010 (1), and the Greece officially requested for the second bailout on 21 July 2011 (4). The settlement date of the tranche of the Irish bailout by the EFSF is on 25 January 2011 (2), and the settlement date of the tranche of the Portugal bailout is on 15 June 2011 (3). The grey parts indicate the typical regime, and the white parts show the atypical regime.





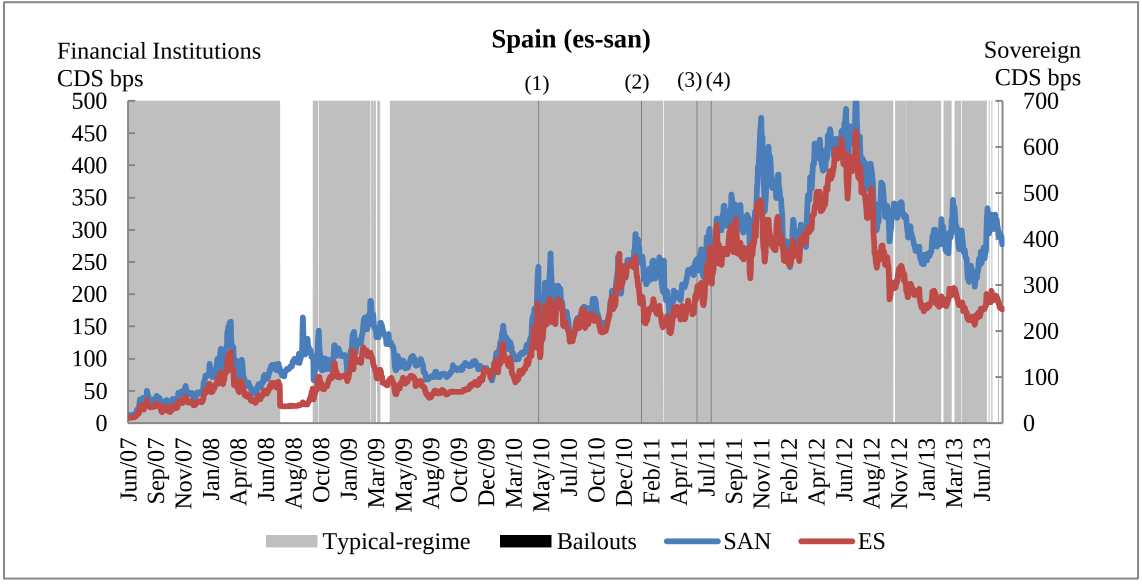


Figure 4.6 *(continued)*

Table 4.1. Summary Statistics for GIIPS Countries

Note: The table shows the summary statistics of CDS spreads, EUR denomination, in basis points. The time series start from 13 November 2007 until 17 February 2012. The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions.

Market	Variable	Obs.	Mean	Min	Max	S.d.
	gr	1225	1373.00	4.40	37081.00	3378.00
Greece	aca	1589	868.90	25.00	2587.00	744.40
	nbg	1227	1097.00	135.00	2648.00	723.60
	ie	1589	274.40	2.00	1191.00	241.10
Ireland	aib	1589	734.30	9.80	1813.00	567.70
	bki	1589	519.60	9.50	2299.00	445.30
	ipm	1589	580.50	14.79	2499.00	527.90
	it	1589	194.80	5.30	586.70	148.80
	bci	1589	183.50	8.50	607.90	144.40
	mdb	1589	178.40	7.20	598.60	132.20
Italy	bmp	1589	265.90	9.50	874.50	224.10
	pii	1589	247.20	13.50	803.80	217.00
	uni	1589	208.30	10.00	678.30	150.00
	ubi	1589	202.20	13.00	661.00	148.40
	gas	1589	162.30	6.70	441.40	106.80
	pt	1589	390.60	3.60	1601.00	397.60
Portugal	bcp	1589	473.00	11.60	1876.00	451.50
	bes	1589	416.40	12.00	1285.00	336.00
	es	1589	210.40	11.50	634.40	145.80
	bbv	1589	196.10	11.00	510.40	120.90
Spain	bkt	1589	296.30	14.79	820.10	207.40
	pop	1589	344.10	14.79	908.90	240.60
	sab	1589	348.60	19.60	837.90	210.40
	san	1589	192.10	11.50	506.70	117.30

Table 4.2. Cointegration Analysis of Linear VECM Estimates for GIIPS Countries

Testing for cointegration

$$\begin{pmatrix}\Delta cds_{Sov,t}\\ \Delta cds_{Fi,t}\end{pmatrix} = \mu + \begin{pmatrix}\alpha_{Sov}\\ \alpha_{Fi}\end{pmatrix} w_{t-1} + \sum_{i=1}^{l}\begin{bmatrix}\gamma_{SovSov,i} & \gamma_{SovFi,i}\\ \gamma_{FiSov,i} & \gamma_{FiFi,i}\end{bmatrix}\begin{pmatrix}\Delta cds_{Sov,t-i}\\ \Delta cds_{Fi,t-i}\end{pmatrix} + u_t .$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. *p*-value in parentheses.

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration	
						β	Constant
Greece	gr	0.01	0.00	0.13	-0.01	1.42	0.24
		(0.00)	(0.00)	(0.04)	(0.01)		
	aca	0.02	0.01	0.04	-0.02		
		(0.00)	(0.00)	(0.04)	(0.01)		
Greece	gr	0.05	0.02	0.13	-0.02	1.43	0.12
		(0.02)	(0.01)	(0.05)	(0.08)		
	nbg	0.02	0.01	0.09	0.01		
		(0.02)	(0.01)	(0.05)	(0.08)		
Ireland	ie	0.01	0.00	-0.22	0.15	1.86	0.42
		(0.02)	(0.00)	(0.10)	(0.05)		
	aib	0.05	0.01	-0.03	0.17		
		(0.02)	(0.00)	(0.10)	(0.05)		
Ireland	ie	0.03	0.00	-0.19	0.10	2.13	0.44
		(0.02)	(0.00)	(0.10)	(0.04)		
	bki	0.06	0.01	0.02	-0.04		
		(0.02)	(0.00)	(0.10)	(0.04)		
Ireland	ie	0.04	0.00	-0.19	0.06	2.71	1.25
		(0.02)	(0.00)	(0.10)	(0.03)		
	ipm	0.04	0.00	0.05	-0.08		
		(0.02)	(0.00)	(0.10)	(0.03)		
Italy	it	0.01	0.00	-0.02	0.17	1.67	0.52
		(0.01)	(0.00)	(0.06)	(0.04)		
	bci	0.03	0.01	0.10	0.07		
		(0.01)	(0.00)	(0.06)	(0.04)		
Italy	it	0.01	0.00	0.05	0.06	1.80	0.38
		(0.01)	(0.00)	(0.05)	(0.03)		
	mdb	0.04	0.01	0.11	0.00		
		(0.01)	(0.00)	(0.05)	(0.03)		
Italy	it	0.02	0.00	0.01	0.10	-5.22	33.84
		(0.01)	(0.00)	(0.06)	(0.05)		
	bmp	0.02	0.00	0.03	0.13		
		(0.01)	(0.00)	(0.06)	(0.05)		

Table 4.2 *(continued)*

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration	
						β	Constant
Italy	it	0.02	0.00	0.02	0.14	-0.03	1.23
		(0.01)	(0.00)	(0.06)	(0.05)		
	pii	0.01	0.00	0.08	0.11		
		(0.01)	(0.00)	(0.06)	(0.05)		
Italy	it	0.01	0.00	-0.01	0.13	1.67	0.22
		(0.01)	(0.00)	(0.06)	(0.05)		
	uni	0.05	0.01	0.02	0.12		
		(0.01)	(0.00)	(0.06)	(0.05)		
Italy	it	-0.01	-0.01	0.07	0.03	1.16	0.08
		(0.00)	(0.00)	(0.05)	(0.02)		
	ubi	0.02	0.02	0.11	0.02		
		(0.00)	(0.00)	(0.05)	(0.02)		
Italy	it	0.02	0.00	0.00	0.14	1.90	0.30
		(0.01)	(0.00)	(0.06)	(0.05)		
	gas	0.05	0.01	0.07	0.11		
		(0.01)	(0.00)	(0.06)	(0.05)		
Portugal	pt	0.01	0.00	0.10	0.11	1.43	0.17
		(0.01)	(0.00)	(0.04)	(0.04)		
	bcp	0.03	0.01	0.12	0.13		
		(0.01)	(0.00)	(0.04)	(0.04)		
Portugal	pt	0.02	0.00	0.10	0.11	1.62	0.13
		(0.01)	(0.00)	(0.04)	(0.05)		
	bes	0.05	0.01	0.09	0.19		
		(0.01)	(0.00)	(0.04)	(0.05)		
Spain	es	0.02	0.01	0.00	0.15	1.25	0.09
		(0.01)	(0.01)	(0.04)	(0.05)		
	bbv	0.03	0.02	0.11	0.10		
		(0.01)	(0.01)	(0.04)	(0.05)		
Spain	es	0.03	-0.01	0.10	0.00	0.44	0.12
		(0.01)	(0.00)	(0.04)	(0.01)		
	bkt	0.00	0.00	0.07	0.00		
		(0.01)	(0.00)	(0.04)	(0.01)		

Table 4.2 *(continued)*

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration	
						β	Constant
Spain	es	0.03	-0.01	0.10	0.01	0.36	0.24
		(0.01)	(0.00)	(0.04)	(0.02)		
	pop	0.00	0.00	0.09	0.04		
		(0.01)	(0.00)	(0.04)	(0.02)		
Spain	es	0.01	0.00	0.08	0.08	1.45	0.23
		(0.01)	(0.00)	(0.04)	(0.06)		
	sab	0.03	0.01	0.10	0.02		
		(0.01)	(0.00)	(0.04)	(0.06)		
Spain	es	0.02	0.01	0.03	0.10	1.33	0.12
		(0.01)	(0.01)	(0.05)	(0.05)		
	san	0.04	0.02	0.13	0.05		
		(0.01)	(0.01)	(0.05)	(0.05)		

Table 4.3. Cointegration Analysis of Typical Regime for GIIPS Countries

Testing for cointegration

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{cases} \mu_1 + \begin{pmatrix} \alpha_{Sov,1} \\ \alpha_{Fi,1} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i,1} & \gamma_{SovFi,i,1} \\ \gamma_{FiSov,i,1} & \gamma_{FiFi,i,1} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_{1t}, \quad if \ w_{t-1} \le \gamma, \\ \mu_2 + \begin{pmatrix} \alpha_{Sov,2} \\ \alpha_{Fi,2} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i,2} & \gamma_{SovFi,i,2} \\ \gamma_{FiSov,i,2} & \gamma_{FiFi,i,2} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_{2t}, \quad if \ w_{t-1} > \gamma, \end{cases}$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. p-value in parentheses.

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration				
Greece	gr	0.00	0.01	0.13	-0.01	$cds_{Sov,t}\leq$	1.45	$cds_{Fi,t}$+(	-1.00	)
		(0.00)	(0.00)	(0.04)	(0.01)					
	aca	0.01	0.02	0.04	-0.02					
		(0.00)	(0.00)	(0.04)	(0.01)					
Greece	gr	0.02	0.01	0.18	0.03	$cds_{Sov,t}\leq$	1.18	$cds_{Fi,t}$+(	-0.68	)
		(0.01)	(0.01)	(0.04)	(0.07)					
	nbg	0.03	0.02	0.14	0.03					
		(0.01)	(0.01)	(0.05)	(0.06)					
Ireland	ie	0.01	0.00	-0.08	0.10	$cds_{Sov,t}>$	1.42	$cds_{Fi,t}$+(	-4.10	)
		(0.02)	(0.01)	(0.06)	(0.05)					
	aib	0.04	0.01	-0.04	0.16					
		(0.01)	(0.00)	(0.06)	(0.05)					
Ireland	ie	0.01	0.00	-0.06	0.09	$cds_{Sov,t}>$	1.57	$cds_{Fi,t}$+(	-4.71	)
		(0.02)	(0.00)	(0.06)	(0.05)					
	bki	0.03	0.01	0.01	-0.03					
		(0.01)	(0.00)	(0.02)	(0.11)					
Ireland	ie	0.03	0.01	-0.06	0.05	$cds_{Sov,t}>$	1.63	$cds_{Fi,t}$+(	-5.35	)
		(0.02)	(0.00)	(0.06)	(0.03)					
	ipm	0.03	0.01	0.04	-0.10					
		(0.02)	(0.01)	(0.02)	(0.03)					
Italy	it	0.02	0.00	0.11	0.13	$cds_{Sov,t}\leq$	2.04	$cds_{Fi,t}$+(	-4.21	)
		(0.01)	(0.00)	(0.05)	(0.05)					
	bci	0.01	0.00	0.14	0.05					
		(0.01)	(0.00)	(0.07)	(0.06)					
Italy	it	0.02	0.00	0.11	0.03	$cds_{Sov,t}\leq$	1.77	$cds_{Fi,t}$+(	-2.78	)
		(0.01)	(0.00)	(0.05)	(0.02)					
	mdb	0.02	0.01	0.13	0.00					
		(0.01)	(0.00)	(0.04)	(0.03)					
Italy	it	0.02	0.00	0.18	0.03	$cds_{Sov,t}>$	-8.62	$cds_{Fi,t}$+(	40.79	)
		(0.01)	(0.00)	(0.06)	(0.05)					
	bmp	0.00	0.00	0.12	0.10					
		(0.01)	(0.00)	(0.07)	(0.08)					

Table 4.3 *(continued)*

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration
Italy	it	0.01	0.00	-0.01	0.16	$cds_{Sov,t} \leq$ 0.69 $cds_{Fi,t}$+(1.83)
		(0.00)	(0.00)	(0.06)	(0.05)	
	pii	0.00	0.00	0.06	0.14	
		(0.00)	(0.00)	(0.03)	(0.05)	
Italy	it	0.02	0.00	0.13	0.05	$cds_{Sov,t} \leq$ 1.76 $cds_{Fi,t}$+(-3.65)
		(0.01)	(0.00)	(0.04)	(0.04)	
	uni	0.04	0.01	0.06	0.05	
		(0.02)	(0.00)	(0.07)	(0.06)	
Italy	it	0.00	-0.01	0.06	0.03	$cds_{Sov,t} \leq$ 1.11 $cds_{Fi,t}$+(-0.22)
		(0.00)	(0.00)	(0.05)	(0.02)	
	ubi	0.01	0.01	0.09	0.01	
		(0.00)	(0.00)	(0.03)	(0.03)	
Italy	it	0.03	0.00	0.08	0.11	$cds_{Sov,t} \leq$ 2.37 $cds_{Fi,t}$+(-5.22)
		(0.01)	(0.00)	(0.06)	(0.06)	
	gas	0.03	0.00	0.11	0.06	
		(0.01)	(0.00)	(0.06)	(0.06)	
Portugal	pt	0.02	0.01	0.12	0.09	$cds_{Sov,t} >$ 1.37 $cds_{Fi,t}$+(-3.05)
		(0.01)	(0.00)	(0.04)	(0.05)	
	bcp	0.03	0.01	0.16	0.14	
		(0.01)	(0.00)	(0.05)	(0.05)	
Portugal	pt	0.02	0.01	0.12	0.08	$cds_{Sov,t} >$ 1.42 $cds_{Fi,t}$+(-3.33)
		(0.01)	(0.00)	(0.05)	(0.05)	
	bes	0.04	0.01	0.13	0.18	
		(0.01)	(0.00)	(0.06)	(0.05)	
Spain	es	0.03	0.03	-0.02	0.18	$cds_{Sov,t} >$ 1.22 $cds_{Fi,t}$+(-1.44)
		(0.01)	(0.01)	(0.06)	(0.06)	
	bbv	0.04	0.04	0.15	0.07	
		(0.01)	(0.01)	(0.05)	(0.06)	
Spain	es	0.01	0.00	0.10	-0.04	$cds_{Sov,t} >$ 0.25 $cds_{Fi,t}$+(2.86)
		(0.01)	(0.00)	(0.04)	(0.04)	
	bkt	0.02	0.00	0.07	-0.04	
		(0.02)	(0.01)	(0.02)	(0.04)	

Table 4.3 *(continued)*

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration
Spain	es	0.01	-0.01	0.11	0.01	$cds_{Sov,t} \leq$ 0.63 $cds_{Fi,t}$+(2.25)
		(0.01)	(0.00)	(0.04)	(0.02)	
	pop	0.00	0.00	0.06	0.05	
		(0.00)	(0.00)	(0.02)	(0.03)	
Spain	es	0.00	0.00	0.08	0.11	$cds_{Sov,t} \leq$ 1.46 $cds_{Fi,t}$+(-2.49)
		(0.01)	(0.00)	(0.04)	(0.06)	
	sab	0.01	0.00	0.10	0.07	
		(0.01)	(0.00)	(0.03)	(0.04)	
Spain	es	0.03	0.03	0.02	0.11	$cds_{Sov,t} >$ 1.20 $cds_{Fi,t}$+(-1.27)
		(0.01)	(0.01)	(0.06)	(0.06)	
	san	0.04	0.04	0.18	0.02	
		(0.01)	(0.01)	(0.06)	(0.06)	

Table 4.4. Cointegration Analysis of Atypical Regime for GIIPS Countries

Testing for cointegration

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{cases} \mu_1 + \begin{pmatrix} \alpha_{Sov,1} \\ \alpha_{Fi,1} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i,1} & \gamma_{SovFi,i,1} \\ \gamma_{FiSov,i,1} & \gamma_{FiFi,i,1} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_{1t}, & if\ w_{t-1} \le \gamma, \\ \mu_2 + \begin{pmatrix} \alpha_{Sov,2} \\ \alpha_{Fi,2} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i,2} & \gamma_{SovFi,i,2} \\ \gamma_{FiSov,i,2} & \gamma_{FiFi,i,2} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_{2t}, & if\ w_{t-1} > \gamma, \end{cases}$$

The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. *p*-value in parentheses.

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration				
Greece	gr	-0.01	-0.02	0.50	-41.75	$cds_{Sov,t}>$	1.45	$cds_{Fi,t}+($	-1.00	)
		(0.02)	(0.02)	(0.08)	(14.01)					
	aca	-0.22	-0.33	-0.10	-39.96					
		(0.21)	(0.32)	(0.20)	(46.60)					
Greece	gr	0.02	0.04	-0.09	-0.57	$cds_{Sov,t}>$	1.18	$cds_{Fi,t}+($	-0.68	)
		(0.01)	(0.02)	(0.14)	(0.36)					
	nbg	0.00	0.00	-0.09	-0.54					
		(0.00)	(0.01)	(0.04)	(0.14)					
Ireland	ie	-0.20	-0.05	-0.91	0.46	$cds_{Sov,t}\leq$	1.42	$cds_{Fi,t}+($	-4.10	)
		(0.72)	(0.17)	(0.12)	(0.19)					
	aib	0.60	0.14	0.04	0.25					
		(0.31)	(0.07)	(0.03)	(0.13)					
Ireland	ie	-0.21	-0.04	-0.58	0.09	$cds_{Sov,t}\leq$	1.57	$cds_{Fi,t}+($	-4.71	)
		(0.15)	(0.03)	(0.23)	(0.05)					
	bki	0.26	0.06	0.06	-0.01					
		(0.17)	(0.03)	(0.03)	(0.05)					
Ireland	ie	-0.17	-0.03	-0.70	0.09	$cds_{Sov,t}\leq$	1.63	$cds_{Fi,t}+($	-5.35	)
		(0.16)	(0.03)	(0.18)	(0.07)					
	ipm	0.18	0.03	0.07	0.03					
		(0.15)	(0.03)	(0.07)	(0.09)					
Italy	it	-0.03	-0.01	-0.29	0.18	$cds_{Sov,t}>$	2.04	$cds_{Fi,t}+($	-4.21	)
		(0.04)	(0.01)	(0.11)	(0.07)					
	bci	0.09	0.02	0.02	0.11					
		(0.06)	(0.01)	(0.09)	(0.10)					
Italy	it	-0.02	-0.01	-0.65	0.44	$cds_{Sov,t}>$	1.77	$cds_{Fi,t}+($	-2.78	)
		(0.05)	(0.02)	(0.15)	(0.18)					
	mdb	0.21	0.07	-0.09	-0.23					
		(0.30)	(0.11)	(0.11)	(0.36)					
Italy	it	0.03	0.00	-0.26	0.15	$cds_{Sov,t}\leq$	-8.62	$cds_{Fi,t}+($	40.79	)
		(0.02)	(0.00)	(0.11)	(0.11)					
	bmp	0.09	0.00	-0.12	0.11					
		(0.05)	(0.00)	(0.07)	(0.11)					

Table 4.4 *(continued)*

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration				
Italy	it	0.53	-0.28	0.37	0.01	$cds_{Sov,t}$>	0.69	$cds_{Fi,t}$+(	1.83	)
		(0.26)	(0.14)	(0.09)	(0.08)					
	pii	-0.23	0.12	0.18	-0.10					
		(0.10)	(0.05)	(0.06)	(0.06)					
Italy	it	0.04	0.01	-0.33	0.34	$cds_{Sov,t}$>	1.76	$cds_{Fi,t}$+(	-3.65	)
		(0.03)	(0.01)	(0.13)	(0.12)					
	uni	0.11	0.03	-0.10	0.28					
		(0.06)	(0.02)	(0.11)	(0.09)					
Italy	it	-0.04	-0.27	0.19	0.32	$cds_{Sov,t}$>	1.11	$cds_{Fi,t}$+(	-0.22	)
		(0.03)	(0.16)	(0.12)	(0.25)					
	ubi	0.16	0.89	0.03	0.15					
		(0.12)	(0.75)	(0.21)	(0.24)					
Italy	it	0.01	0.00	-0.48	0.12	$cds_{Sov,t}$>	2.37	$cds_{Fi,t}$+(	-5.22	)
		(0.03)	(0.01)	(0.19)	(0.12)					
	gas	0.05	0.01	-0.08	0.47					
		(0.06)	(0.01)	(0.06)	(0.16)					
Portugal	pt	-0.53	-0.17	0.01	0.07	$cds_{Sov,t}$≤	1.37	$cds_{Fi,t}$+(	-3.05	)
		(0.25)	(0.08)	(0.09)	(0.06)					
	bcp	0.90	0.29	-0.18	0.15					
		(0.22)	(0.07)	(0.08)	(0.07)					
Portugal	pt	-0.72	-0.21	0.01	0.05	$cds_{Sov,t}$≤	1.42	$cds_{Fi,t}$+(	-3.33	)
		(0.30)	(0.09)	(0.11)	(0.11)					
	bes	0.69	0.20	-0.15	0.26					
		(0.28)	(0.08)	(0.09)	(0.14)					
Spain	es	0.02	0.00	0.03	-0.03	$cds_{Sov,t}$≤	1.22	$cds_{Fi,t}$+(	-1.44	)
		(0.03)	(0.02)	(0.02)	(0.08)					
	bbv	-0.04	-0.02	-0.03	0.07					
		(0.07)	(0.04)	(0.03)	(0.24)					
Spain	es	0.02	0.01	0.11	0.00	$cds_{Sov,t}$≤	0.25	$cds_{Fi,t}$+(	2.86	)
		(0.05)	(0.02)	(0.14)	(0.00)					
	bkt	0.03	-0.01	0.07	0.01					
		(0.03)	(0.01)	(0.07)	(0.00)					

Table 4.4 *(continued)*

Country	$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration
Spain	es	0.10	-0.04	0.06	-1.52	$cds_{Sov,t} > 0.63\ cds_{Fi,t} + (\ 2.25\ )$
		(0.10)	(0.04)	(0.09)	(1.33)	
	pop	0.49	-0.17	0.33	-5.22	
		(0.46)	(0.16)	(0.33)	(8.66)	
Spain	es	0.00	-0.01	0.07	0.01	$cds_{Sov,t} > 1.46\ cds_{Fi,t} + (\ -2.49\ )$
		(0.04)	(0.02)	(0.13)	(0.15)	
	sab	0.02	0.00	0.00	-0.13	
		(0.04)	(0.02)	(0.07)	(0.13)	
Spain	es	-0.03	-0.02	0.02	-0.01	$cds_{Sov,t} \leq 1.20\ cds_{Fi,t} + (\ -1.27\ )$
		(0.02)	(0.01)	(0.02)	(0.06)	
	san	-0.04	-0.02	-0.04	-0.02	
		(0.04)	(0.03)	(0.03)	(0.16)	

Table 4.5. Impulse Responses in Typical and Atypical Regimes for GIIPS Countries

A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. The test statistics with * indicate significant at the 10%. The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions.

Country	Imp.	Resp.	Typical Regime				Atypical Regime			
			1	2	5	22	1	2	5	22
Greece	gr	aca	0.04	0.06	0.09*	0.27*	0.00	0.00	0.00	0.00
			(1.02)	(1.30)	(2.10)	(3.85)	(0.78)	(0.95)	(1.11)	(0.98)
	aca	gr	-0.01	-0.02	-0.04	-0.11	-34.99*	-33.03*	-24.83*	-1.93
			(-0.66)	(-0.85)	(-1.23)	(-1.36)	(-917.20)	(-8.89)	(-5.03)	(-0.64)
	gr	nbg	0.18*	0.23*	0.31*	0.61*	-0.08*	-0.03*	-0.05*	-0.04
			(7.54)	(7.93)	(8.72)	(7.34)	(-2.64)	(-1.97)	(-2.16)	(-0.64)
	nbg	gr	0.00	0.00	-0.04	-0.19	-0.49*	-0.42*	-0.89*	-2.81*
			(0.07)	(0.05)	(-0.40)	(-0.82)	(-2.13)	(-2.78)	(-2.80)	(-1.99)
Ireland	ie	aib	-0.01	0.00	0.04*	0.19*	-0.02	0.09	0.24*	0.21*
			(-0.71)	(0.05)	(1.72)	(4.05)	(-0.15)	(0.74)	(2.14)	(1.93)
	aib	ie	0.16*	0.15*	0.17*	0.24*	0.62*	0.97*	1.19*	1.06*
			(3.43)	(3.55)	(3.56)	(2.36)	(2.37)	(3.16)	(3.08)	(2.91)
	ie	bki	0.03	0.04*	0.09*	0.27*	0.14*	0.15*	0.27*	0.40*
			(1.45)	(2.69)	(5.05)	(7.94)	(2.04)	(4.33)	(5.83)	(8.48)
	bki	ie	0.11*	0.10*	0.11*	0.13*	0.13*	0.12*	0.19*	0.27*
			(2.82)	(2.87)	(2.76)	(1.66)	(2.78)	(3.11)	(2.99)	(2.60)
	ie	ipm	0.05*	0.05*	0.08*	0.19*	0.33*	0.34*	0.41*	0.48*
			(2.45)	(3.28)	(4.49)	(5.66)	(3.75)	(4.33)	(6.21)	(6.28)
	ipm	ie	0.07*	0.05*	0.06*	0.09	0.15*	0.25*	0.43*	0.58*
			(2.27)	(2.35)	(2.32)	(1.53)	(2.01)	(3.53)	(4.15)	(3.92)

Table 4.5 *(continued)*

Impulse Responses

Country	Imp.	Resp.	Typical Regime 1	Typical Regime 2	Typical Regime 5	Typical Regime 22	Atypical Regime 1	Atypical Regime 2	Atypical Regime 5	Atypical Regime 22
Italy	it	bci	0.15*	0.19*	0.23*	0.36*	0.05	0.12*	0.25*	0.42*
			(3.96)	(4.18)	(4.62)	(4.43)	(0.85)	(3.45)	(6.44)	(10.09)
	bci	it	0.14*	0.16*	0.16*	0.12	0.13*	0.08*	0.08	0.06
			(5.89)	(5.64)	(4.40)	(1.27)	(2.46)	(1.94)	(1.30)	(0.66)
	it	mdb	0.13*	0.15*	0.18*	0.30*	0.09	0.11*	0.16*	0.25*
			(4.56)	(4.91)	(5.64)	(5.34)	(1.50)	(1.86)	(2.22)	(2.59)
	mdb	it	0.05*	0.06*	0.08*	0.14	0.22	0.35*	0.66*	1.22*
			(2.01)	(2.16)	(2.24)	(1.62)	(1.56)	(2.55)	(3.63)	(3.15)
	it	bmp	0.12*	0.16*	0.18*	0.27*	-0.09	-0.07	-0.05	0.05
			(3.21)	(3.30)	(3.44)	(2.58)	(-1.44)	(-1.28)	(-0.82)	(0.54)
	bmp	it	0.02	0.02	0.01	-0.02	0.16*	0.14*	0.14*	0.11
			(0.52)	(0.48)	(0.32)	(0.20)	(2.95)	(2.76)	(2.14)	(0.81)
	it	pii	0.06*	0.07*	0.07*	0.08	0.38*	0.48*	0.45*	0.39*
			(2.42)	(2.43)	(2.34)	(1.38)	(5.25)	(5.29)	(3.36)	(3.24)
	pii	it	0.15*	0.17*	0.19*	0.25	0.28*	0.47*	0.59*	0.51*
			(4.64)	(4.72)	(4.81)	(3.63)	(3.33)	(5.14)	(7.52)	(6.56)
	it	uni	0.08*	0.12*	0.19*	0.41*	-0.02	0.08	0.28*	0.56*
			(2.25)	(2.83)	(4.29)	(6.13)	(-0.28)	(1.45)	(5.23)	(8.82)
	uni	it	0.08*	0.09*	0.10*	0.13	0.30*	0.26*	0.18*	0.06
			(2.86)	(2.87)	(2.39)	(1.19)	(5.99)	(4.71)	(2.48)	(0.52)
	it	ubi	0.15*	0.17*	0.23*	0.40*	0.08*	0.14*	0.19*	0.18*
			(4.56)	(5.11)	(6.24)	(6.77)	(1.72)	(2.10)	(1.98)	(1.87)
	ubi	it	0.04*	0.06*	0.12*	0.30*	0.70*	1.08*	1.23*	1.17*
			(2.00)	(2.82)	(4.13)	(4.56)	(4.20)	(5.17)	(6.86)	(5.92)
	it	gas	0.12*	0.14*	0.17*	0.28*	-0.05	-0.01	0.11	0.39*
			(3.67)	(3.91)	(4.44)	(4.40)	(-0.64)	(-0.08)	(1.30)	(4.16)
	gas	it	0.11*	0.13*	0.12*	0.07*	0.12	0.11	0.09	-0.02
			(4.35)	(4.17)	(3.20)	(0.76)	(0.84)	(0.72)	(0.42)	(-0.05)

(Continued)

Table 4.5 *(continued)*

Country	Imp.	Resp.	Typical Regime 1	Typical Regime 2	Typical Regime 5	Typical Regime 22	Atypical Regime 1	Atypical Regime 2	Atypical Regime 5	Atypical Regime 22
Portugal	pt	bcp	0.15*	0.21*	0.27*	0.50*	0.30*	0.54*	0.52*	0.47*
			(5.62)	(6.01)	(6.86)	(6.86)	(3.11)	(7.61)	(8.11)	(7.58)
	bcp	pt	0.10*	0.12*	0.12*	0.07*	0.32*	0.38*	0.33*	0.30*
			(3.30)	(3.19)	(2.54)	(0.65)	(3.40)	(3.87)	(3.80)	(3.79)
	pt	bes	0.14*	0.19*	0.26*	0.49*	0.11	0.29*	0.39*	0.35*
			(4.97)	(5.41)	(6.56)	(7.50)	(1.19)	(3.75)	(5.71)	(5.29)
	bes	pt	0.08*	0.10*	0.09*	0.01	0.44*	0.57*	0.57*	0.52*
			(2.71)	(2.57)	(1.84)	(0.06)	(4.27)	(4.64)	(4.49)	(4.47)
Spain	es	bbv	0.20*	0.25*	0.38*	0.80*	-0.01	0.01	0.06	0.09
			(5.56)	(6.48)	(7.37)	(6.43)	(-0.16)	(0.16)	(0.61)	(0.78)
	bbv	es	0.14*	0.13*	0.06	-0.18	0.24	0.48*	0.90*	1.10*
			(3.61)	(2.94)	(1.05)	(-1.13)	(1.47)	(3.15)	(4.49)	(2.56)
	es	bkt	0.08*	0.08*	0.09*	0.14*	0.27	0.36	0.55	0.71*
			(5.01)	(5.09)	(5.08)	(3.31)	(0.82)	(1.15)	(1.63)	(1.71)
	bkt	es	-0.04	-0.04	-0.02	0.05	0.03	0.05*	0.11*	0.16*
			(-0.91)	(-0.81)	(-0.50)	(0.97)	(0.96)	(1.94)	(3.12)	(2.52)
	es	pop	0.11*	0.13*	0.16*	0.27*	-0.00*	-0.00*	-0.00*	0.00
			(3.55)	(3.75)	(4.16)	(3.61)	(-4.55)	(-3.93)	(-2.08)	(0.11)
	pop	es	0.01	0.02	0.02	0.04	0.05	0.10	0.22*	0.60*
			(0.54)	(0.59)	(0.71)	(0.73)	(1.60)	(1.62)	(1.67)	(1.85)
	es	sab	0.12*	0.14*	0.17*	0.27*	0.05	0.10	0.20*	0.42
			(7.04)	(7.22)	(7.54)	(5.57)	(0.57)	(1.08)	(1.90)	(2.20)
	sab	es	0.08*	0.09*	0.09*	0.09	0.10	0.12	0.16	0.24
			(1.81)	(1.81)	(1.67)	(0.84)	(0.88)	(1.07)	(1.34)	(1.31)
	es	san	0.22*	0.28*	0.41*	0.84*	0.03	0.06	0.13	0.22*
			(5.67)	(6.62)	(7.72)	(6.97)	(0.33)	(0.86)	(1.54)	(1.86)
	san	es	0.09*	0.06	-0.01	-0.29*	0.12	0.33*	0.72*	1.19
			(2.19)	(1.47)	(-0.24)	(-1.87)	(0.94)	(2.67)	(4.24)	(3.35)

CHAPTER FIVE:

FUNCTIONAL COINTEGRATION OF SOVEREIGN DEFAULT RISK VIA INVESTMENT SENTIMENT

5. Functional Cointegration of Sovereign Default Risk via Investor Sentiment

5.1. Introduction

Default probabilities and recovery capability of economies vary through business cycles (Acharya *et al*. (2011)). Changes in sovereign default risk of countries could have contagious influence on each other via changing the supply and demand of foreign credit, since investors' perceptions are responsive to market instability (Drudi and Giordano (2000), Dooley and Verma (2001) and Tomz and Wright (2008)). It is essential to investigate the interactions of countries' default risk so that to foresee the risk transmission cross-country and to prevent further deterioration.

The main objective in this study is to investigate the functional cointegrated relationship between two series of sovereign default risk of the Eurozone countries via a functional coefficient, which is the investor sentiment in the two countries, since investor sentiment is the most important determinant of default risk (Tang and Yan (2010)). The findings show that, investor sentiment predicts jumps or regimes in countries' default risk. The long-run relationship of countries' default risk changes in different regimes. When the economic environment is stable, the gap between two countries' default risk is small, and it is easier for one country to close the gap of default risk towards the other. During crisis time, however, the trench of default risk between countries is larger, and the elasticity of the countries' default risk is smaller, indicating more difficulties to drive the two countries' default risk back towards the normal status.

Recent literature on the dynamics of countries' default risk and other financial variables has focused on nonlinear regime models with parametric specifications such as threshold models and others with structural breaks. This study however, uses an alternative model by allowing the coefficients of linear structures to be functional following the methodology by Banerjee and Pitarakis (2013). Such models with semiparametric specifications are generally referred as functional coefficient models, which can avoid the problematic nature of the nonparametric structures such as spurious correlation (see Granger and Newbold (1974)).

The meaning of cointegration is that the linear combination of the non-stationary variables is stationary, which indicates that the variables involved in the regression do not drift apart through time, and that the cointegrating vector reveals the long-run relationship of the variables (see Engle and Granger (1987)). Furthermore, it is possible that there are shifts in the cointegrating vector, which means the long-run relationship changes, and non-linear regime models have been introduced with one or more structural breaks in cointegration (see Gregory and Hansen (1996a) and Hatemi-J (2008)). However, for the semiparametric model, the functional coefficients within the simple linear structure are able to capture more specifications such as regime shifts.

To capture the sovereign default risk, the study uses sovereign credit default swap (CDS) spreads of ten European countries, including Austria (AT), Belgium (BE), Denmark (DK), France (FR), Germany (DE), Italy (IT), Netherland (NL), Spain (ES), Sweden (SE), and the United Kingdom (UK) from January 2004 to September 2013. Germany CDS spreads are used as the benchmark default risk, since German financial performance has been relatively more stable than other European countries, especially than other Eurozone countries, and German government has been the main contributor of the bailouts during the global financial crisis and the recent European sovereign debt crisis. The cointegration of sovereign default risk between Germany and one of the other European countries is examined, and the functional coefficients are regressions of investor sentiment. For countries' investor sentiment, the study applies three measures, which are Consumer Confidence Indicator (CCI), put-call trading volume ratio (PCV) and put-call open interest ratio (PCO).

Behavioural theories suggest that market optimism or pessimism or fluctuations in the economic environment could make asset prices deviate from their intrinsic values (see Chung *et al* (2012), De Long *et al* (1990) and Kumar and Lee (2006)). Recent financial economists have indicated that investor sentiment is an important factor which affects the returns and volatility of assets, especially for the stock market. Previous research has shown that the mispricing is corrected when the economic fundamental are revealed and is reflected in sentiment directly. This suggests the predictive power of investor sentiment for pricing correction.

When recent European sovereign debt crisis develops, more and more attention has been concentrated at the pricing correction power on credit spreads, as credit default swap spreads measure the default risk of an entity. Tang and Yan (2010) have concluded through empirical analysis on corporate CDS spreads that investor sentiment is the most important determinant of default risk.

The investigation in this chapter contributes to the application of investor sentiment in analysing the pricing correction of sovereign default risk. More specifically, for the application of the model, the gap of the default risk between the benchmark country and the other European country changes during the crises, and the functional coefficients of investor sentiment measure the mispricing of the default risk of the underlying country and the adjustment speed for the country to close this gap. The results show that, during crisis periods, the pricing correction power of the sovereign default risk is weaker for most countries towards a relatively stable level.

The remaining part of this study is organised as follows. Section 5.2 is the data description. Section 5.3 explains the estimation methodology. Section 5.4 analyses the results, and section 5.5 concludes.

5.2. Data Description

5.2.1. Sovereign Default Risk

The study uses CDS spreads to capture credit default risk of the government. Studies have shown that CDS spreads can measure investors' risk preference. According to Hull *et al*. (2004), both changes and levels of CDS spreads contain significant information in estimating the probability of rating events, but CDS spread changes conditional on rating events, and downgrade announcement and negative outlooks do not have helpful information. Ismailescu and Kazemi (2010) analyse the relationship between the sovereign CDS spreads and the sovereign credit rating, and show that investors can make decisions according to the same public information that would lead to the changes in CDS spreads prior to a rating announcement.

The daily data of CDS spreads is collected from DataStream. The selection of sovereign CDS series was restricted by data availability. Ten European countries is included, namely Austria (AT), Belgium (BE), Denmark (DK), France (FR), Germany (DE), Italy (IT), Netherland (NL), Spain (ES), Sweden (SE), and the United Kingdom (UK). Five-year CDS is used, since it is the largest and the most liquid constituent of the CDS markets, and the restructuring types for the sovereign CDS series are all Complete Restructuring (CR).

[Insert Figure 5.1]

The data set starts from January 2004 to September 2013. Figure 5.1 shows the sovereign CDS spreads for the ten countries in the sample. The CDS spreads for the European countries increase in 2009 which is the period of global financial crisis. The CDS spreads also increase sharply after 2010 which is the Eurozone crisis, especially for Italy and Spain. Table 5.1 reports summary statistics of the CDS spreads of the countries. The table shows that the mean and standard deviation of CDS spreads are especially high for Italy and Spain, indicating their sovereign default risk is high and unstable.

[Insert Table 5.1]

5.2.2. Investor Sentiment

Previous research has been using the composite index of investor sentiment firstly introduced by Baker and Wurgler (2006), the Conference Board Consumer Confidence Index or the University of Michigan's Consumer Sentiment Index when analysing the U.S. market (see Chung *et al*. (2012), Ho and Hung (2012), Mclean and Zhao (2012) and Tang and Yan (2010)). Ho and Hung (2012) firstly apply Consumer Confidence Indicator (CCI) developed by the European Commission for the European countries, and this study also uses CCI as one of the sentiment measures. The CCI is based on harmonised surveys for different sectors of the countries in the European Union (EU). For analysing high frequency data of sovereign default risk of each country, the monthly CCI data is transferred into daily data by applying the same value in a month.

For the high frequency data, the put-call trading volume ratio (PCV) and the put-call open interest ratio (PCO) are also used, which are introduced in Wang *et al*. (2006). PCV is the ratio of trading volume of put options to call options, and PCO is the ratio of open interest of put to call options. Since market participants buy put options when they are pessimistic of the market, the PCV or the PCV ratio goes up indicating higher mispricing of the assets. The continuous series of option data is chosen from Thomson Financial for the European countries (see Appendix 17), and the trading volume and the open interest are the total trading volume and the open interest of all puts or calls for the day for all expiry months, respectively.

[Insert Table 5.2]

Table 5.2 show the summary statistics of the CCI, PCV and PCO indices. The table shows that the mean of CCI indices for Italy and Spain are low, -25 and -24, respectively, while no obvious difference are found when checking the PCO and PCV ratios.

5.3. Estimation Methodology

The methodology applies the model by Banerjee and Pitarakis (2013) to examine the functional cointegration of two countries' default risk via the investor sentiment as the functional coefficient. The following functional coefficient model is considered:

$$cds_{Sov,t} = f_0(sent_{t-1}) + f_1(sent_{t-1})cds_{de,t} + u_t \,, \tag{5.1}$$

$$cds_{de,t} = cds_{de,t-1} + v_t \,. \tag{5.2}$$

where $cds_{Sov,t}$ is sovereign CDS spread in log-level of the European countries at day *t*, and $cds_{de,t}$, German CDS spreads in log-level, is taken as $I(1)$ process. $sent_t$ is the residuals generated from the linear regression of the two countries' CCI, PCV or PCO, and $f_0(sent_t)$ and $f_1(sent_t)$ are the unknown functional regressions of $sent_t$. The functional coefficients can be specialised to parametric specifications such as threshold effects, or polynomial expressions, i.e., $f_i(sent_{t-1}) = \sum_{j=0}^{n} \beta_{i,j} sent_{t-1}^{j}$ among others.

To explore the reliable estimates of the functional coefficients and to test their consistency, the piecewise local linear estimation method (PLLE) method by Banerjee (2007) is applied in the context of average derivative estimation. The full range of $sent_t$ is separated in to k disjoint bins of equal length. The optional k is selected via a standard selection based approach. Lower bound k_{min} and upper bound k_{max} are set for the number of bins, and the optimal k is chosen according to the minimisation of an AIC type of criterion. For every $sent_t$ falling in a certain bin, the corresponding $cds_{Sov,t}$ and $cds_{de,t}$ are connected to fit the least square line in that bin. As these bins are disjoint, there is no overlapping data of $cds_{Sov,t}$ and $cds_{de,t}$ for different locations of $sent_t$ under the PLLE method.

Fluctuations in the economic environment may cause the fact that the combination of two countries' default risk derives from their long-run equilibrium, and in the functional cointegration model, $f_0(sent_{t-1})$ measures the mispricing of the two countries' default risk, which is the gap of sovereign default risk between $cds_{Sov,t}$ and $cds_{de,t}$, while $cds_{de,t}$ is considered as the benchmark of European default risk. $f_1(sent_{t-1})$ reflects how the default risk of other European country responds when the default risk of Germany changes. $f_1(sent_{t-1})$ is the adjustment speed of the two countries closing the gap of default risk. In other words, $f_1(sent_{t-1})$ is the driving force of cds_{Sov} to the more stable cds_{de}.

When the optimal number of bins k is larger than 2, the estimates of the functional coefficients $f_0(sent_t)$ and $f_1(sent_t)$ is considered to be polynomial regression of $sent_t$ in the following expressions:

$$\hat{f}_0(sent_{t-1}) = \beta_{0,0} + \beta_{0,1} sent_{t-1} + \beta_{0,2} sent_{t-1}^2 + \beta_{0,2} sent_{t-1}^3 + v_{0,t}\ , \tag{5.3}$$

$$\hat{f}_1(sent_{t-1}) = \beta_{1,0} + \beta_{1,1} sent_{t-1} + \beta_{1,2} sent_{t-1}^2 + \beta_{1,2} sent_{t-1}^3 + v_{1,t}\ . \tag{5.4}$$

If the optimal number of bins k is 2, the model suggests that the functional coefficients $f_0(sent_{t-1})$ and $f_1(sent_{t-1})$ are specialised to the two-regime shifts. In the two-regime semiparametric model, $f_0(sent_{t-1})$ and $f_1(sent_{t-1})$ shift in opposite directions, i.e., when $f_0(sent_{t-1})$ has the lower value, $f_1(sent_{t-1})$ has the higher value. The regime, in which $f_0(sent_{t-1})$ has the lower value, and $f_1(sent_{t-1})$ has the higher value, is defined as *typical* regime or common regime, and the opposite regime as the *atypical* regime or crisis regime. During the typical regime, the gap of default risk between the underlying country and Germany is small, which indicates that the underlying country has lower default probability, and the adjustment speed is higher suggesting that it is easier for the underlying country to move closer to its long-run level. During the atypical regime or in the crisis, the default risk of the underlying country rises and causes bigger gap between the two countries, and on the other hand, since the response of the underlying country is slow, lower adjustment speed suggesting that it is more difficult to move back to its long-run equilibrium.

5.4. Empirical Findings

This section analyses the linkages of sovereign default risk between the European countries via investor sentiment by applying Banerjee and Pitarakis (2013) Piecewise Local Linear estimation (PLLE) method.

First, the results of the model are examined using the put-call open interest ratio

(PCO) as investor sentiment. PCO is daily data and covers data of all the ten European countries. Table 5.3 shows the results of cointegration tests of sovereign default risk using PCO. Panel A of Table 5.3 shows the countries that can be linear cointegrated, since their ADF *p*-values are smaller than 0.1, which means that they do not have unit roots significantly. The ADF *p*-values for Austria (AT), Belgium (BE) and Sweden (SE) are 0.01, 0.05 and 0.08, respectively. Then the linear coefficients α_0 and α_1 are checked for each pair of countries (Austria/Belgium/Sweden and Germany). The linear coefficients α_0 and α_1 are all significant at 0.1 level. Despite the signs of the α_0 coefficients, the absolute α_0 value for the linkage between Belgium and Germany is 26.37, which is the largest suggesting relatively largest gap of default risk between the underlying country and Germany. On the other hand, the α_1 coefficient of the linkage between Belgium and Germany (4.45) is also the largest among three, indicating that the adjustment speed of Belgium is also higher in order to close the gap towards the benchmark country, Germany.

[Insert Table 5.3]

Panel B and Panel C in Table 5.3 show the countries that cannot be linear cointegrated, but the linear coefficients α_0 and α_1 are still displayed for comparison purpose. In Panel B and Panel C, the linear ADF *p*-values are all larger than 0.1, suggesting that they statistically cannot reject the null hypothesis of having unit roots.

Panel B lists the countries which cointegration with German default risk has optimal k=2 bins, and these countries are France (FR), Netherlands (NL), Spain (ES) and the United Kingdom (UK). The right side of Panel B shows the ADF *p*-values in the semiparametric model and the values of functional coefficients f_0 and f_1. The ADF *p*-values for all the countries are all 0, indicating that the variables can be functional cointegrated. Since the optimal number of bins k is 2, the functional coefficients f_0 and f_1 are two piecewise functions of $sent_{t\text{-}1}$, which means the functional coefficients f_0 and f_1 are bivalued and fall into two regimes. From the results of the functional coefficients when k=2, an interesting phenomenon for all the countries (FR, NL, ES and UK) is that when the value of $f_0(sent_{t\text{-}1})$ is lower, $f_1(sent_{t\text{-}1})$ is higher, and vice versa. The cointegration of default risk between Spain and Germany is showed as an example. When $f_0(sent_{t\text{-}1})$ is 14.75, $f_1(sent_{t\text{-}1})$ is 5.20; when $f_0(sent_{t\text{-}1})$ is 21.31, $f_1(sent_{t\text{-}1})$ is 1.80. The former situation with lower f_0 and higher f_1 is defined as *typical* regime or common regime, and the latter one with higher f_0 and lower f_1 as *atypical* regime or crisis regime. Since in the typical regime, the default risk of the underlying country is lower and more stable, suggesting lower gap to the default risk of the benchmark country; the response of the underlying country is quick in order to close the gap between the two countries. During the atypical regime or during crisis period in other words, however, the CDS spread of the underlying country can rise sharply in the short term, causing the trench of default risk further widen between the country and the benchmark. On the other hand, the adjustment speed f_1 is higher compared to that in the typical regime, indicating that the problem is getting worse and it is more difficult for the country to close this gap.

The red dots in Figures 5.2-5.4 show the distribution of functional coefficients with time. If the countries can be functional cointegrated, and the optimal number of bins is 2, then the red dots are bi-valued; if the number of bins is larger than 2, the layers of red dots show the number of bins, and the smoothed curves of their polynomial regressions would be shown below. Figure 5.2 illustrates the functional coefficients of PCO when k=2 for France, Netherlands, Spain and UK. For example, in the case of France, k=2 which means the series of CDS spreads of France can be functional cointegrated with German CDS spreads with two optimal bins. When $f_0(sent_{t\text{-}1})$ is lower (-3.51), $f_1(sent_{t\text{-}1})$ is higher (2.15); When $f_0(sent_{t\text{-}1})$ is higher (16.72), $f_1(sent_{t\text{-}1})$ is lower (1.45). It is obvious from the figure that each of the functional coefficients is bivalued, and the atypical regime with higher f_0 and lower f_1 is mainly located around late 2009 and the period from 2010 to 2012, and these periods are the 2008-2009 global financial crisis and the European sovereign debt crisis from May 2010. The figure provides further evidence that the functional coefficients of $sent_{t\text{-}1}$ are capable to capture the structural features and to position the regime shifts.

[Insert Figure 5.2]

Panel C in Table 5.3 shows the results of countries that can be functional cointegrated with optimal k larger than to 2. The linear ADF *p*-values for Denmark and Italy are 0.51 and 0.24, respectively, indicating that they cannot be linear cointegrated. In the right side of the table, the AIC ADF *p*-values are all 0, which means the countries are functional cointegrated. Polynomial regressions are applied for the functional coefficients for the $f_0(sent_{t\text{-}1})$ and $f_1(sent_{t\text{-}1})$. For Italy, the polynomial coefficients are all significant at 0.1 level, and for Denmark, of $\beta_{0,1}$ of $f_0(sent_{t\text{-}1})$ and $\beta_{1,0}$ and $\beta_{1,1}$ of $f_1(sent_{t\text{-}1})$ are significant. Such results suggest that the coefficients are non-linear, and the data is more suitable with functional cointegration. Figure 5.3 shows the results of functional coefficients of PCO when k is larger than 2, and Panel A and B are Denmark and Italy, respectively. The first two charts in each panel are the distribution of functional coefficients $f_0(sent_{t\text{-}1})$ and $f_1(sent_{t\text{-}1})$ with time, and the other two are the polynomial regressions of the functional coefficients. From the first two charts, it shows that when f_0 is lower, f_1 is higher, and vice versa. The points with high f_0 and low f_1 are mainly located after 2010 for Denmark and late 2009 for Italy, suggesting that in these periods, the countries are in the atypical regime that their gaps of default risk are larger, and it is more difficult for them to respond, especially for Italy.

[Insert Figures 5.3 and 5.4]

Table 5.4 shows the results of cointegration tests of sovereign default risk using the put-call volume ratio (PCV). PCV is also daily data, but due to data availability of trading volume of put/call options, only the data of Austria (AT), Sweden (SE), Italy (IT), Netherland (NL) and the United Kingdom (UK) is available. Panel A of Table 5.4 shows that Austria and Sweden cannot be linear cointegrated, and Panel B shows that the other three countries are functional cointegrated. The optimal k is 2 for the functional cointegration, and the results of all the countries in Panel B show the same results as using PCO as investor sentiment that when f_0 is lower, f_1 is higher, and vice versa. For example, when the functional coefficient f_0 is 31.13, f_1 is 4.03, and when f_0 is 24.57, f_1 is 5.03. Figure 5.4 is the charts of the functional coefficients with time for Italy, Netherland and UK when optimal k is 2. For example, in the case of Italy, k=2 means the series of CDS spreads of Italy can be functional cointegrated with German CDS spreads with two optimal bins. When $f_0(sent_{t-1})$ is lower (24.57), $f_1(sent_{t-1})$ is higher (5.03); When $f_0(sent_{t-1})$ is higher (31.13), $f_1(sent_{t-1})$ is lower (4.03). Such results provide similar evidence that functional cointegration can measure the regime shifts.

[Insert Tables 5.4 and 5.5]

Table 5.5 is the results of cointegration of sovereign default risk using Consumer Confidence Indicator (CCI) as the investor sentiment. Since CCI is monthly data, the monthly CCI is transferred into daily data by applying the same value in a month, and the functional cointegration model is used to see whether similar results can be found. The findings show that the optimal k is larger than 2 for the countries which cannot be linear cointegrated (see Panel B). The right side of Panel B shows the results of polynomial regressions for the functional coefficients f_0 and f_1, and most of the polynomial coefficients are significant, suggesting that the coefficients are not constant. But the $\beta_{0,0}$ coefficients are very large, for example, for Italy and Spain are 84.56 and 93.80, respectively. $\beta_{0,0}$ coefficients are the constant terms in the polynomial regressions of f_0, and larger $\beta_{0,0}$ coefficients suggests that the CDS spread level gap between the underlying country and the benchmark Germany is larger. The results of CCI show similar results as PCO and PCV, suggesting that when the variables are not linear cointegrated, the functional cointegration tests can be applied on the variables, which reveal more features of the relationship.

5.5. Conclusion

In this chapter, the semiparametric models introduced by Banerjee and Pitarakis (2013) are used to analyse the cointegrated relationship of sovereign default risk of the European countries, and the functional coefficients of the relationship are regressions on an investor sentiment variable. The study uses three measures of investor sentiment, which are Consumer Confidence Indicator (CCI), put-call trading volume ratio (PCV) and put-call open interest ratio (PCO).

The results show that when the variables cannot be linear cointegrated, the functional cointegration are more suitable for the data. The functional coefficients are able to capture the structural features or the regimes shifts. The findings indicate that in the typical regime, the default risk of the underlying country is lower and more stable, suggesting lower gap to the default risk of the benchmark country; the response of the underlying country is quick in order to close the gap between the two countries. During the crisis periods, however, the CDS spread of the underlying country can rise sharply in the short term, causing the trench of default risk further widen between the country and the benchmark; the adjustment speed is slower compared to that in the typical regime, indicating that it is more difficult for the country to close this gap.

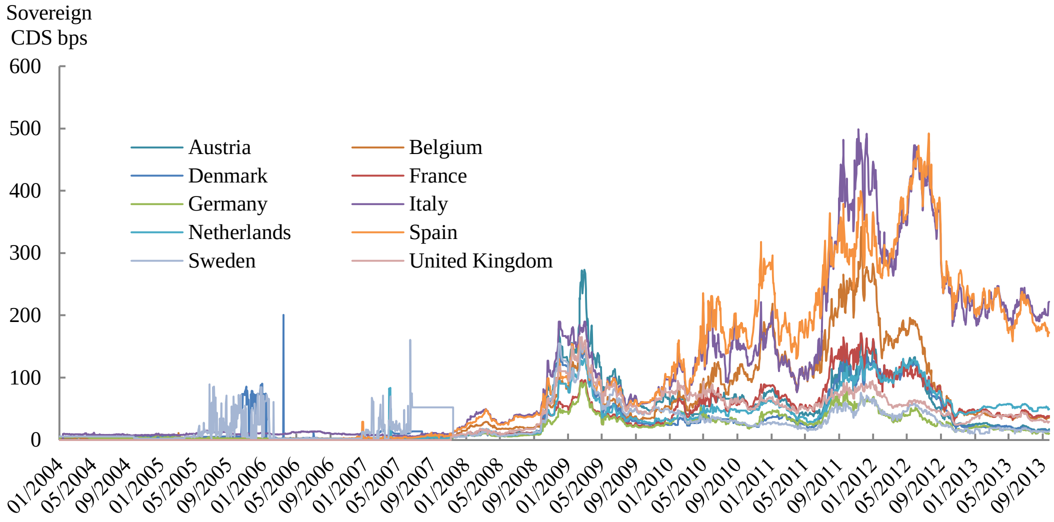
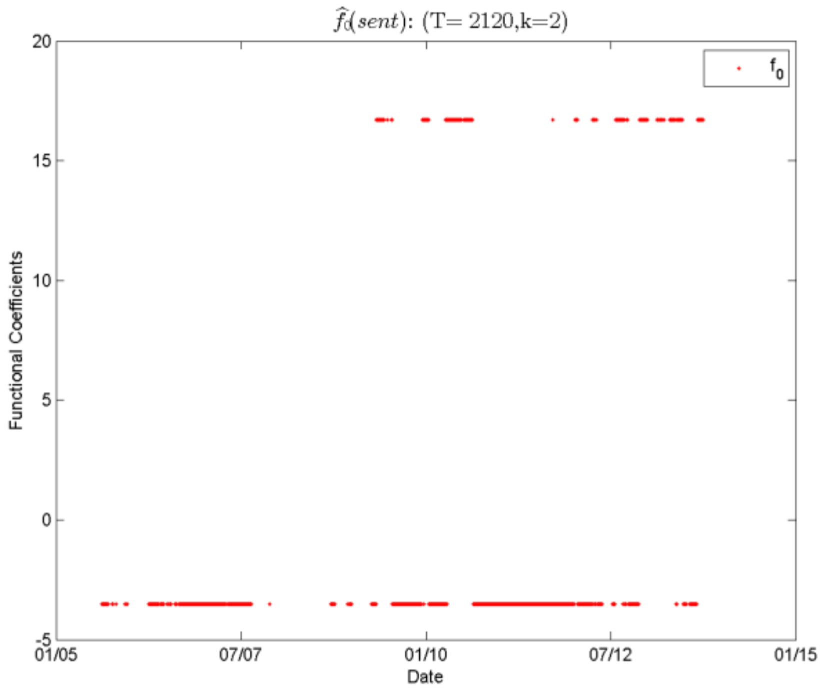
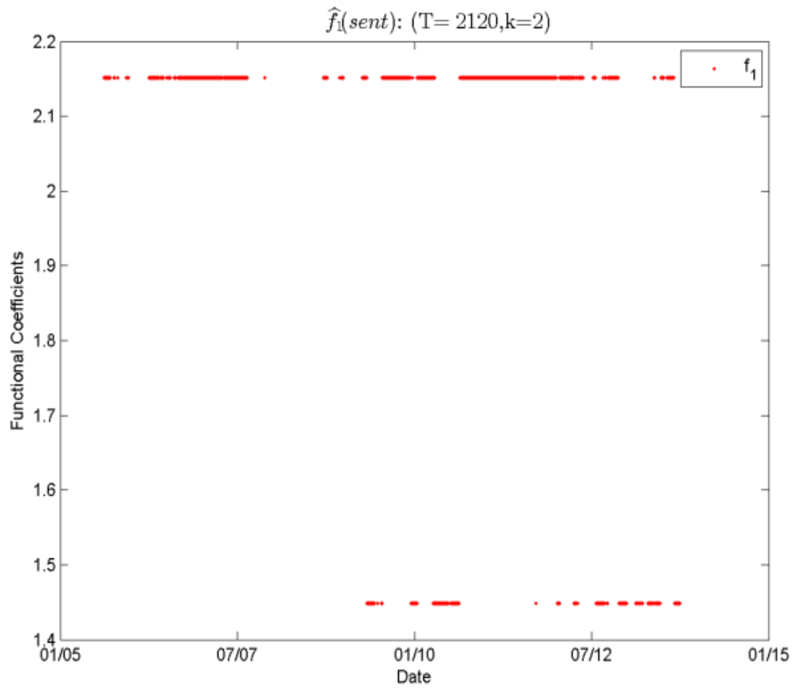


Figure 5.1. Sovereign CDS spreads for ten European countries

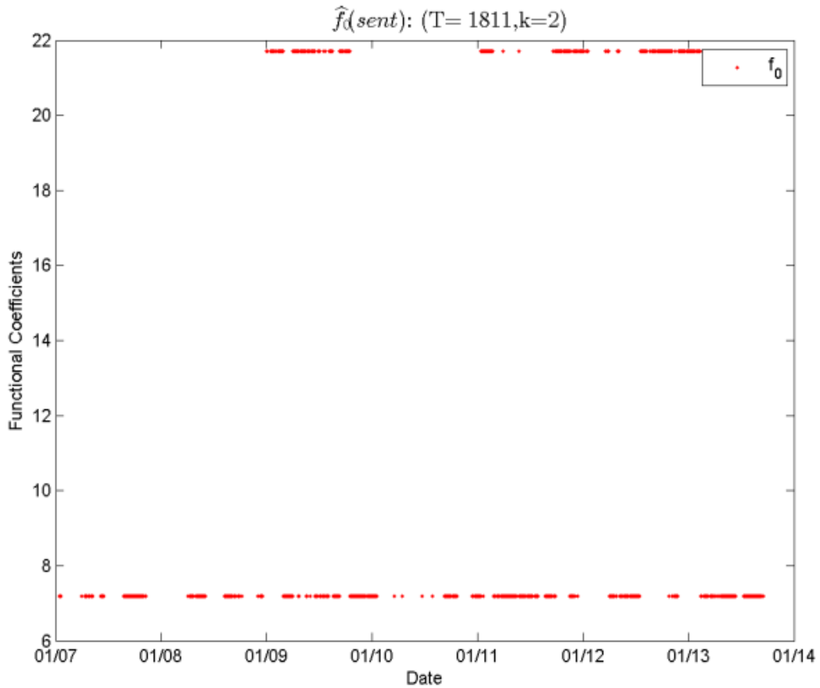
The figure plots the daily five-year senior CDS spreads in basis points of the ten European countries, including Austria (AT), Belgium (BE), Denmark (DK), France (FR), Germany (DE), Italy (IT), Netherlands (NL), Spain (ES), Sweden (SE) and the United Kingdom (UK), from 07 January 2004 to 30 September 2013.

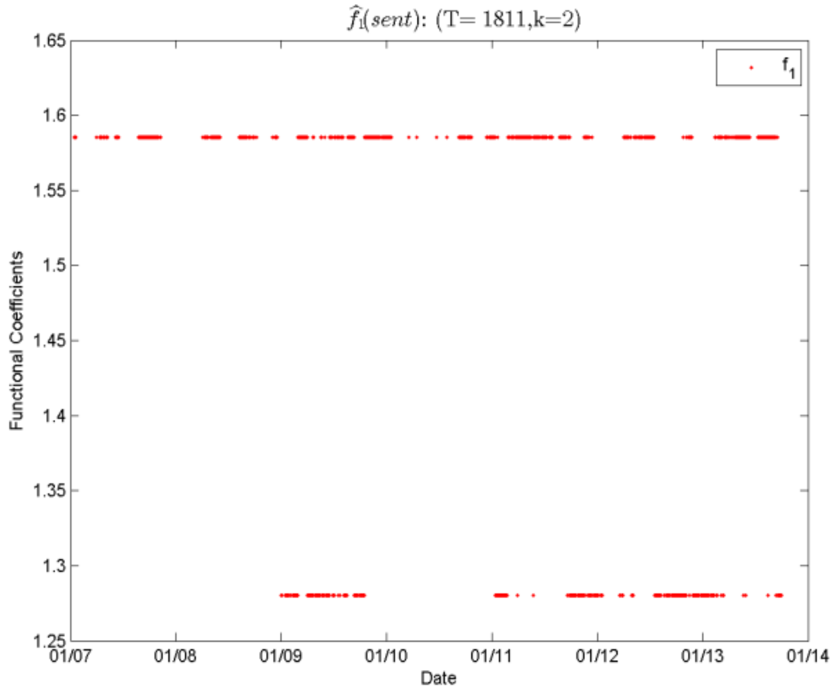
Panel A. France



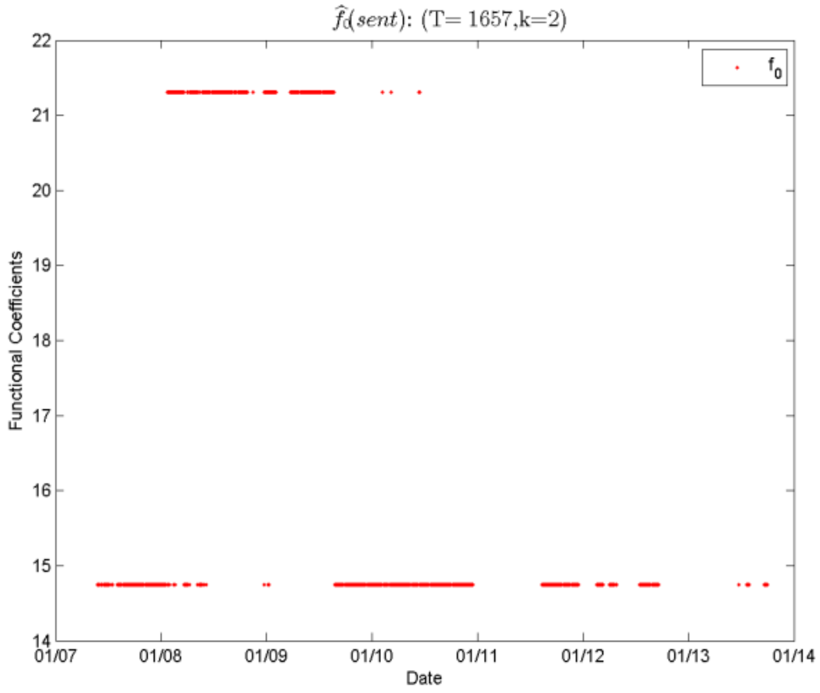


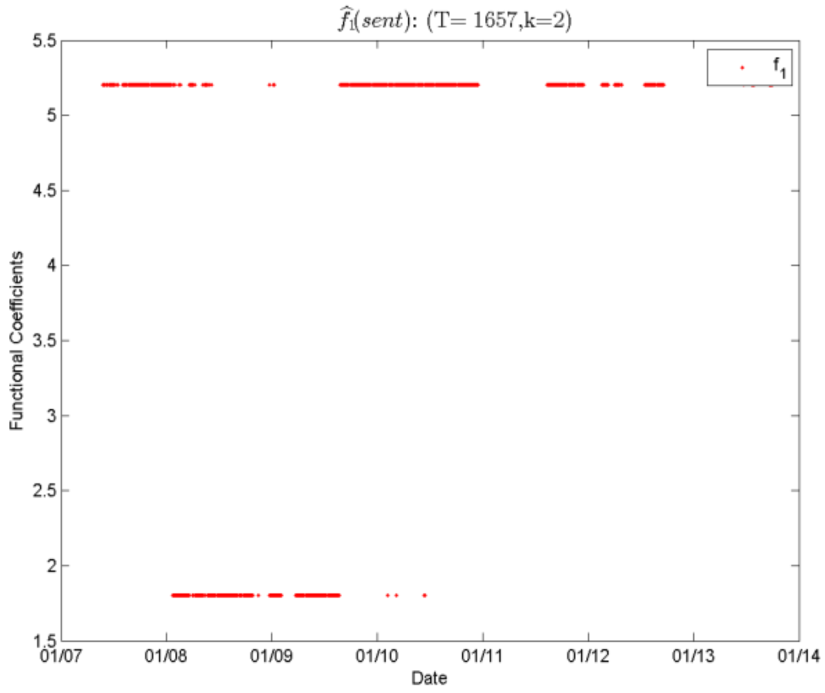
Panel B. Netherlands



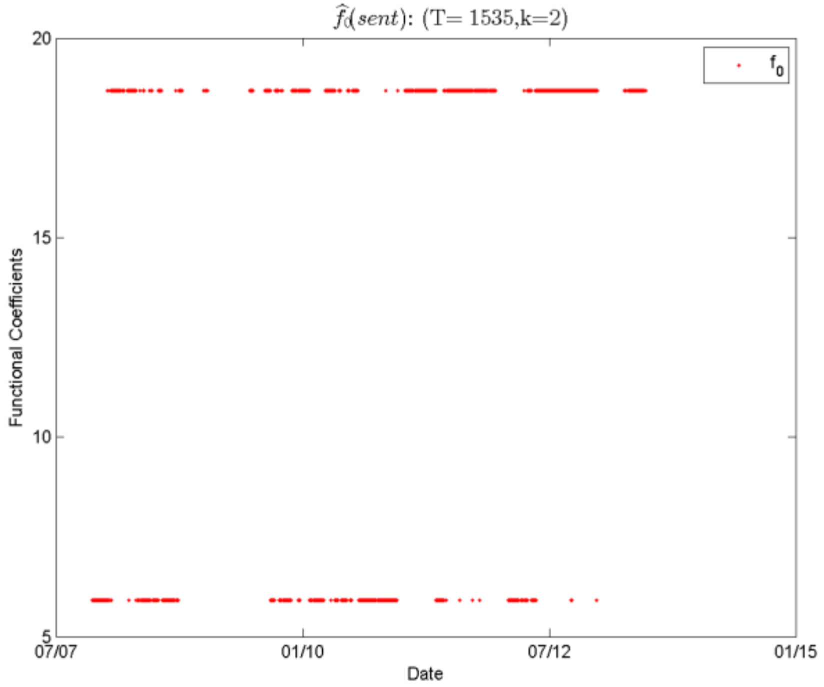


Panel C. Spain





Panel D. UK



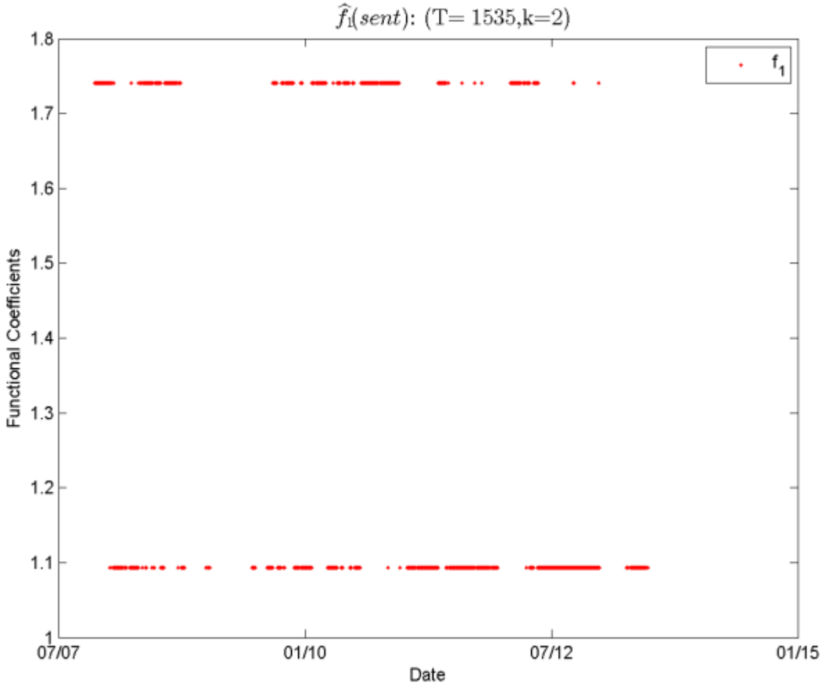
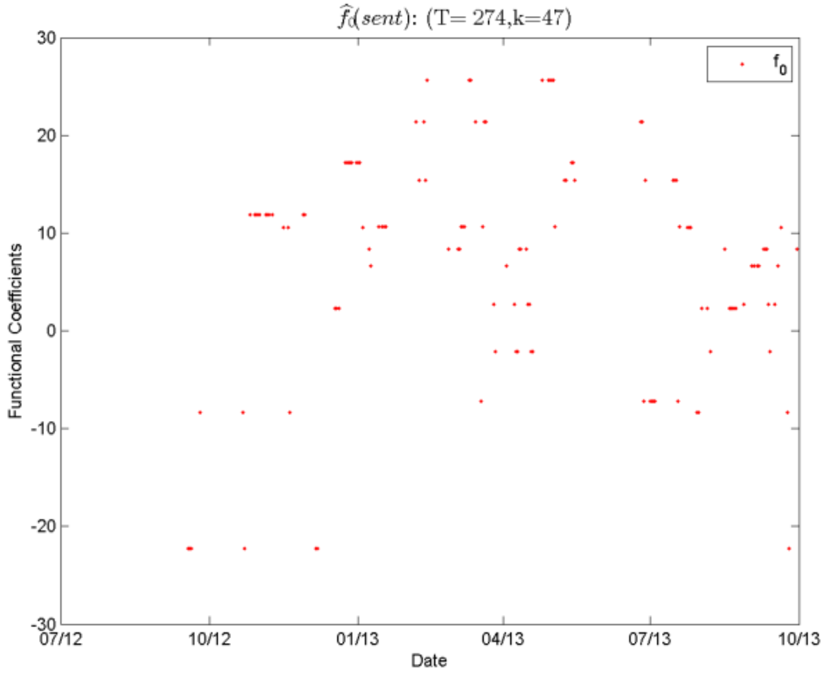
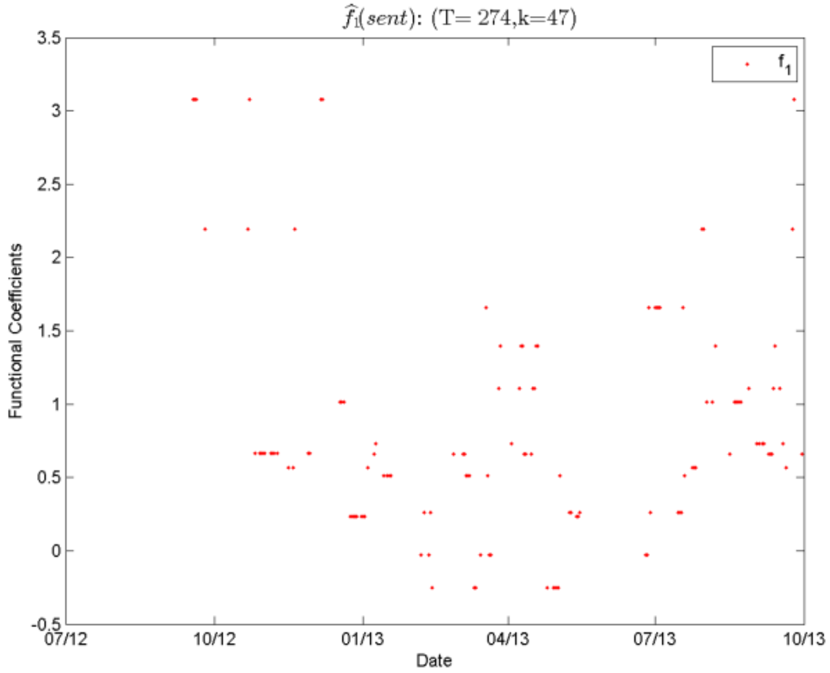


Figure 5.2. Functional Coefficients of PCO in Cointegration of Sovereign Default Risk when *k*=2

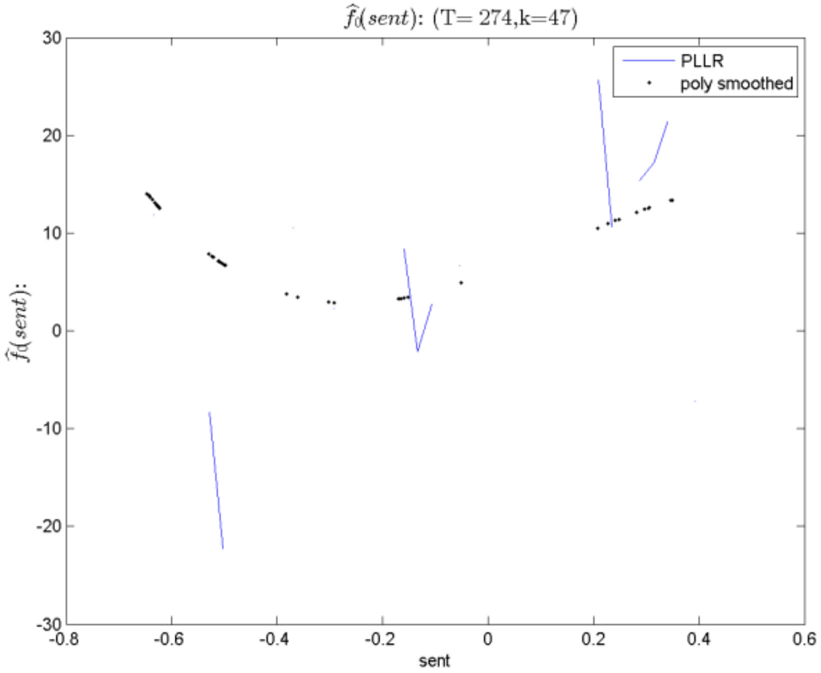
The figure plots the estimates of the functional coefficients of investor sentiment using PCO under the optimal bins (*k*=2). The red dots show the distribution of functional coefficients with time. If the countries can be functional cointegrated, and the optimal number of bins is 2, then the red dots are bi-valued. For example, in the case of France, *k*=2 means the series of CDS spreads of France can be functional cointegrated with German CDS spreads with two optimal bins. When $f_0(sent_{t-1})$ is lower (-3.51), $f_1(sent_{t-1})$ is higher (2.15); When $f_0(sent_{t-1})$ is higher (16.72), $f_1(sent_{t-1})$ is lower (1.45).

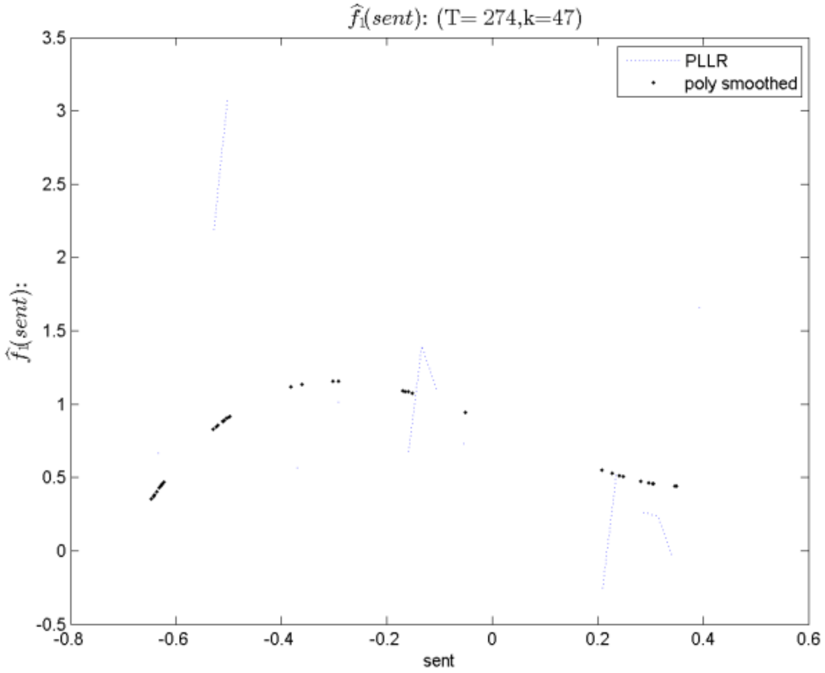
Panel A. Denmark



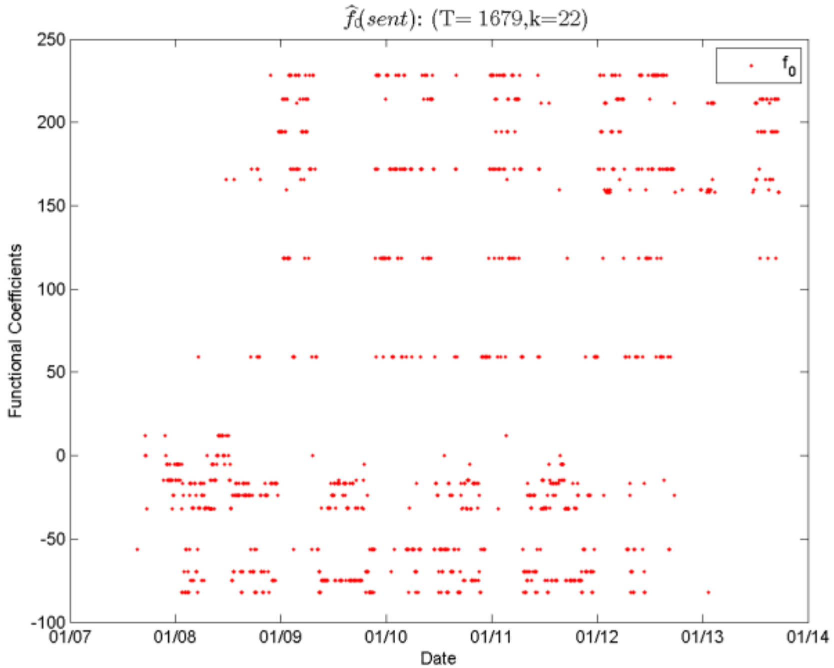


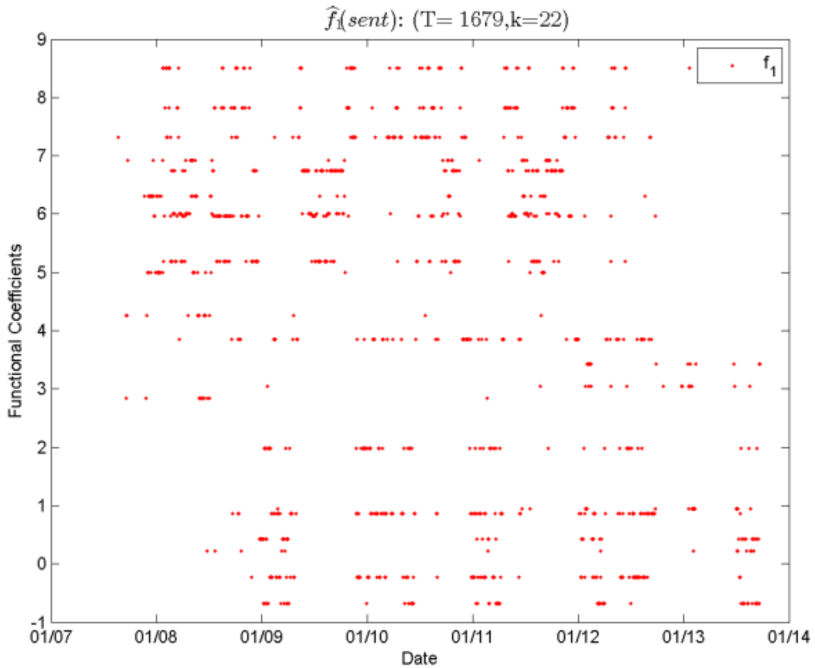
Panel A. Denmark (*continued*)



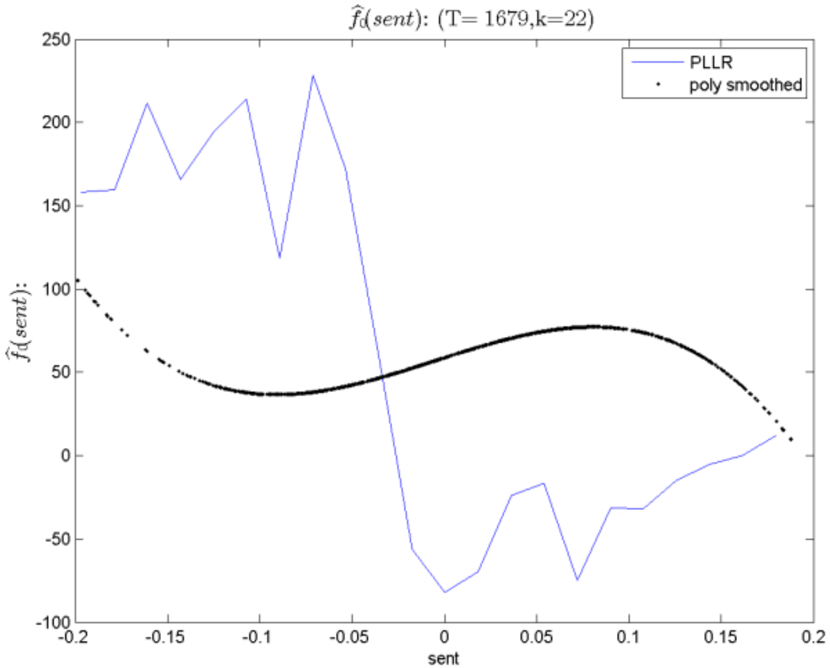


Panel B. Italy





Panel B. Italy (*continued*)



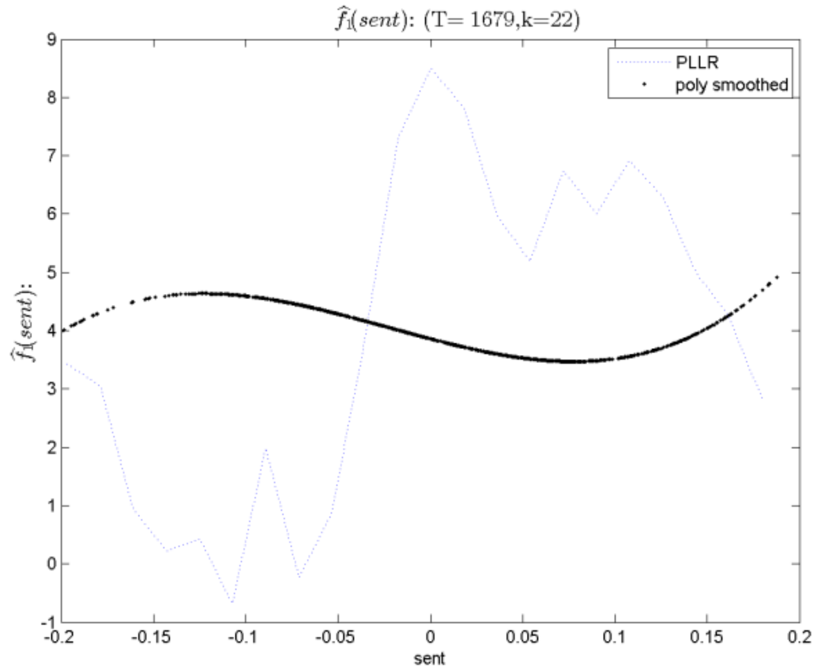
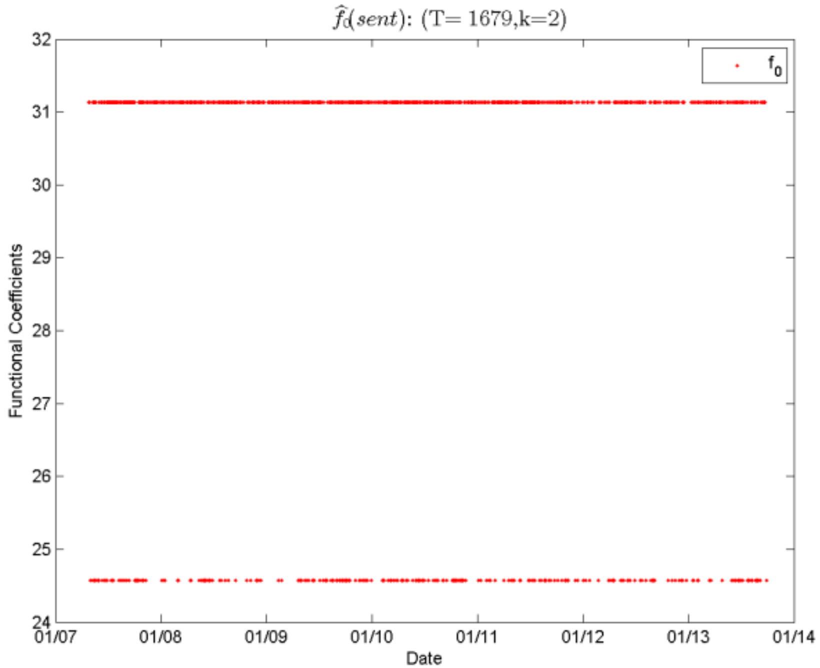
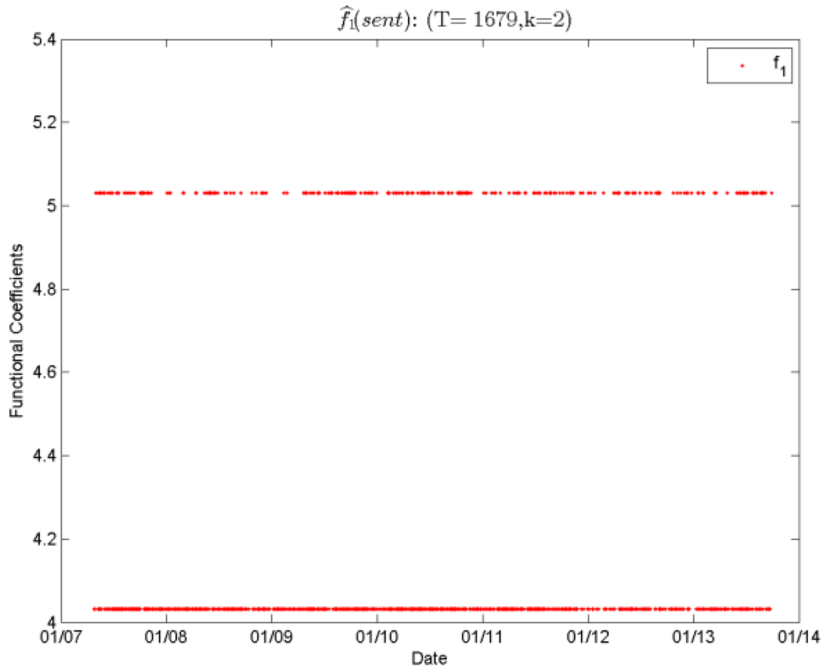


Figure 5.3. Functional Coefficients of PCO in Cointegration of Sovereign Default Risk when *k*>2

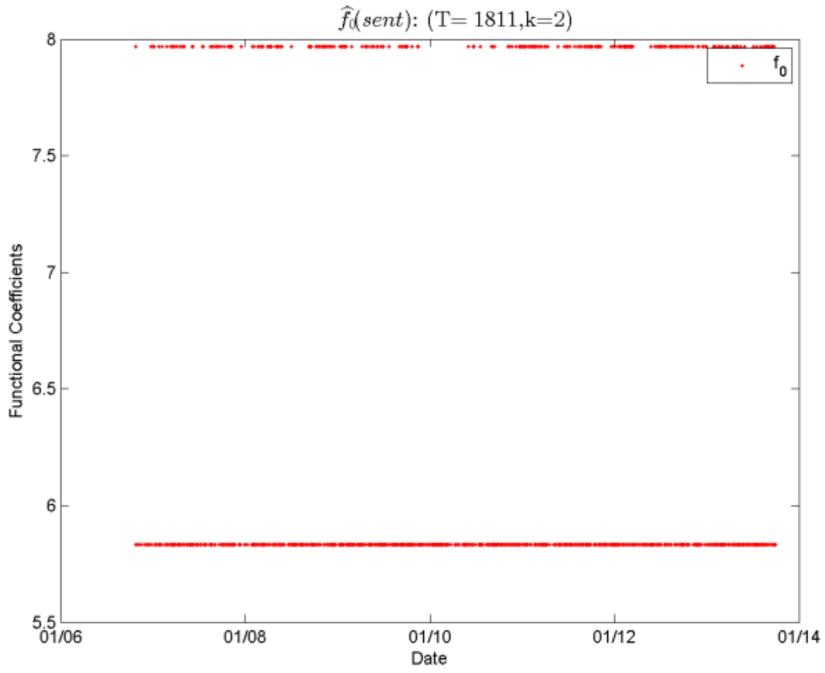
The figure plots the estimates of the functional coefficients of investor sentiment using PCO under the optimal bins (*k*>2). If the countries can be functional cointegrated, and the optimal number of bins is larger than 2, the layers of red dots show the number of bins, and the smoothed curves of their polynomial regressions would be shown below.

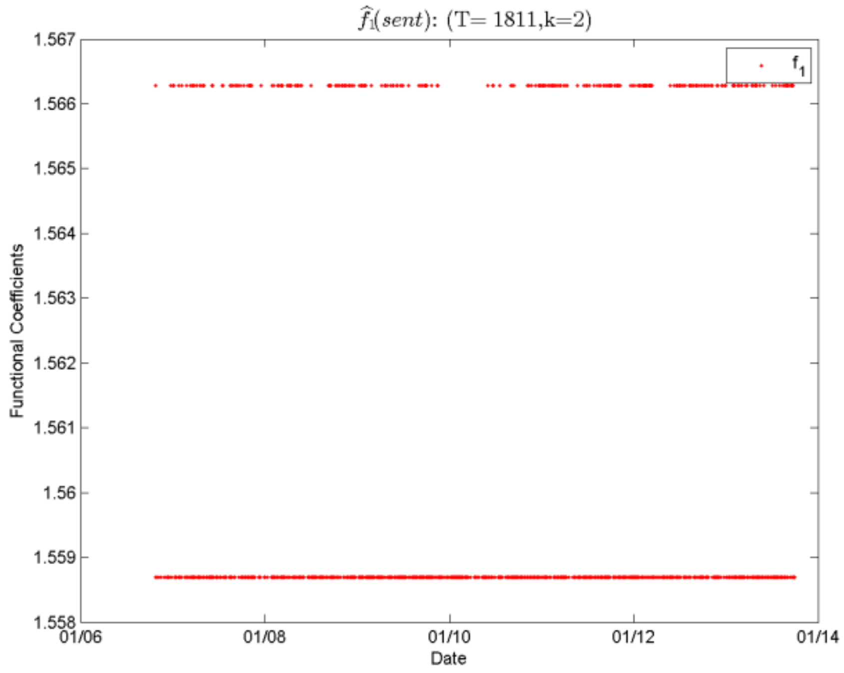
Panel A. Italy





Panel B. Netherlands





Panel C. UK

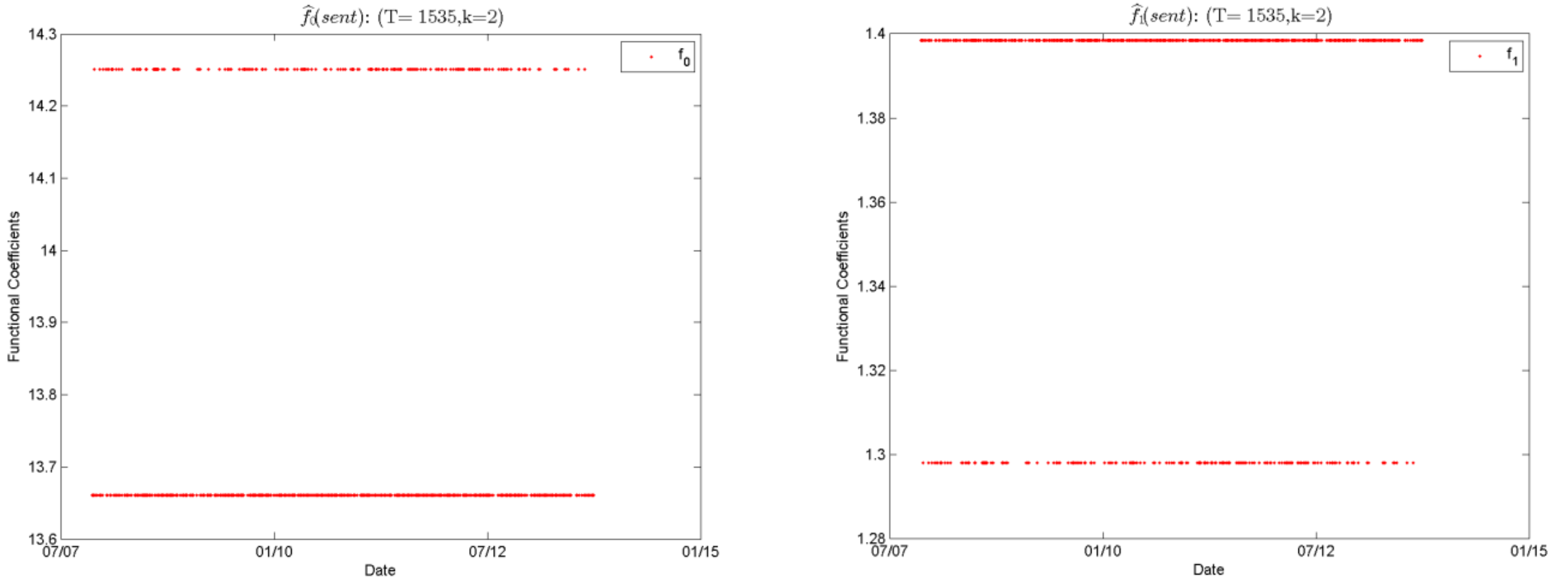


Figure 5.4. Functional Coefficients of PCV in Cointegration of Sovereign Default Risk when *k*=2

The figure plots the estimates of the functional coefficients of investor sentiment using PCV under the optimal bins (k=2). The red dots show the distribution of functional coefficients with time. If the countries can be functional cointegrated, and the optimal number of bins is 2, then the red dots are bi-valued. For example, in the case of Italy, k=2 means the series of CDS spreads of Italy can be functional cointegrated with German CDS spreads with two optimal bins. When $f_0(sent_{t-1})$ is lower (24.57), $f_1(sent_{t-1})$ is higher (5.03); When $f_0(sent_{t-1})$ is higher (31.13), $f_1(sent_{t-1})$ is lower (4.03).

Table 5.1. Summary Statistics of CDS Spreads of Ten European Countries

This table shows the means, minimum values, maximum values, standard deviations and numbers of observations of the sovereign CDS spreads with Euro denomination in basis points. The time series start from 07 January 2004 until 30 September 2013.

Variable	Mean	Min	Max	Std. Dev.	Obs
Austria	38.57	0.50	273.00	46.45	2539
Belgium	54.59	1.00	341.98	66.51	2539
Denmark	31.84	1.60	200.56	36.62	2539
France	41.53	0.50	171.56	39.14	2120
Germany	18.92	0.60	92.50	18.75	2538
Italy	108.80	5.30	498.66	121.80	2530
Netherlands	45.68	1.00	133.84	34.78	1811
Spain	149.50	2.25	492.07	119.04	1811
Sweden	27.99	1.00	160.80	27.75	2539
UK	55.50	4.50	165.00	28.86	1535

Table 5.2. Summary Statistics of CCI, PCO and PCV

This table shows the means, minimum values, maximum values, standard deviations and numbers of observations of the CCI, PCO and PCV indices for the European countries. Consumer Confidence Indicator (CCI) is developed by the European Commission based on harmonised surveys for different sectors of the EU members. The time series of CCI start from 01 November 2006 until 30 September 2013. Put-call open interest ratio (PCO) is the ratio of open interest of put to call options, and put-call trading volume ratio (PCV) is the ratio of trading volume of put to call options. The time series of PCO and PCV starts from 07 January 2004 until 30 September 2013. The variables of PCO and PCV are chosen according to data availability, and the number of observations in each regression is decided by variable having less observations.

Panel A. CCI					
Variable	Mean	Min	Max	Std. Dev.	Obs
Austria	-1.27	-23.00	16.30	10.04	1803
Belgium	-10.28	-26.50	2.90	7.94	1803
Denmark	8.37	-7.40	19.00	6.34	1803
France	-20.82	-37.00	1.80	8.76	1803
Germany	-5.20	-32.90	10.90	10.99	1803
Italy	-25.00	-41.50	-13.80	7.20	1803
Netherlands	-6.03	-30.20	20.30	14.05	1803
Spain	-24.18	-47.60	-10.00	9.83	1803
Sweden	12.04	-10.00	28.00	9.75	1803
UK	-15.23	-35.20	-1.00	8.18	1803
Panel B. PCO					
Variable	Mean	Min	Max	Std. Dev.	Obs
Austria	2.07	0.28	11.57	1.65	2526
Belgium	1.78	0.00	19.50	2.83	684
Denmark	1.30	0.34	3.60	0.64	274
France	1.16	0.12	1.85	0.18	2186
Germany	1.29	0.88	1.69	0.19	2534
Italy	1.01	0.55	1.84	0.18	1679
Netherlands	1.09	0.79	1.75	0.11	2532
Spain	1.10	0.00	157.82	5.46	1655
Sweden	1.09	0.45	1.85	0.32	1634
UK	1.26	0.90	1.55	0.14	2536
Panel C. PCV					
Variable	Mean	Min	Max	Std. Dev.	Obs
Austria	3.54	0.00	323.00	13.52	1674
Germany	1.33	0.31	7.27	0.48	2482
Italy	1.09	0.22	4.87	0.39	1635
Netherlands	1.18	0.07	3.19	0.29	2494
Sweden	1.28	0.14	8.39	0.78	1576
UK	1.52	0.19	10.75	0.82	2458

Table 5.3. Linear and Non-Linear Cointegration Tests of Sovereign Default Risk via PCO

This table shows results of linear and non-linear cointegration tests of the sovereign default risk via functional coefficients of investment sentiment using PCO. Each regression tests the relationship of sovereign default risk between Germany and one of other European countries. Panel A shows the variables that can be linear cointegrated, and the ADF *p*-values and the linear coefficients are displayed with *t*-values in parentheses.

Panel B uses the following functional coefficient model:

$$cds_{Sov,t} = f_0(sent_{t-1}) + f_1(sent_{t-1})cds_{de,t} + u_t \,,$$

$$cds_{de,t} = cds_{de,t-1} + v_t \,.$$

In Panel B, variables cannot be linear cointegrated while their optimal *k* is two in the semiparametric specifications. The linear coefficients are showed for comparison. The functional coefficients of investor sentiment under the two bins (*k*=2) are showed separately.

Panel C shows the variables that cannot be linear cointegrated while their optimal *k* is larger than two. Polynomial regressions of investor sentiment with the following expressions are applied:

$$\hat{f}_0(sent_{t-1}) = \beta_{0,0} + \beta_{0,1}sent_{t-1} + \beta_{0,2}sent_{t-1}^2 + \beta_{0,2}sent_{t-1}^3 + v_{0,t} \,,$$

$$\hat{f}_1(sent_{t-1}) = \beta_{1,0} + \beta_{1,1}sent_{t-1} + \beta_{1,2}sent_{t-1}^2 + \beta_{1,2}sent_{t-1}^3 + v_{1,t} \,.$$

The polynomial coefficients of the functional specifications are displayed with t-values in parentheses.

Panel A: Linear Cointegrated			
Country	Linear adf *p*-value	Linear coefficients	
		α_0	α_1
Austria	0.01	-5.41***	2.33***
		(-11.96)	(136.82)
Belgium	0.05	-26.37***	4.45***
		(-12.94)	(80.89)
Sweden	0.08	9.85***	0.99***
		(9.97)	(33.34)

Table 5.3 (*continued*)

Panel B: Functional Cointegrated with Optimal k=2

	Linear			Non-linear			
Country	Linear adf	Linear coefficients		Optimal k	AIC adf	Functional coefficients	
	p-value	α_0	α_1		p-value	f_0	f_1
France	0.14	1.41**	1.82***	2	0.00	-3.51	2.15
		(2.37)	(89.28)			16.72	1.45
Netherlands	0.34	5.22***	1.59***	2	0.00	7.20	1.59
		(7.18)	(68.91)			21.71	1.28
Spain	0.26	63.49***	3.61***	2	0.00	14.75	5.20
		(14.80)	(27.72)			21.31	1.80
UK	0.18	12.08***	1.47***	2	0.00	18.68	1.09
		(17.16)	(71.34)			5.92	1.74

Panel C: Functional Cointegrated with Optimal k>2

	Linear			Non-linear									
Country	Linear adf	Linear coefficients		Optimal k	AIC adf	Polynomial coeff. of $f(0)$ t-stats. in parentheses				Polynomial coeff. of $f(1)$ t-stats. in parentheses			
	p-value	α_0	α_1		p-value	$\beta_{0,0}$	$\beta_{0,1}$	$\beta_{0,2}$	$\beta_{0,3}$	$\beta_{1,0}$	$\beta_{1,1}$	$\beta_{1,2}$	$\beta_{1,3}$
Denmark	0.51	-2.83**	1.46	47	0.00	5.88	20.20*	20.01	-47.55	0.86***	-1.58**	-0.61	4.72
		(-2.06)	(18.66)			(1.19)	(1.78)	(0.37)	-0.52	(2.64)	(-2.10)	(-0.17)	(0.78)
Italy	0.24	43.99***	4.23***	22	0.00	58.70***	354.33***	-246.59	-16,137.18***	3.86***	-8.28***	19.68*	290.17***
		(10.54)	(33.15)			(13.42)	(4.70)	(-0.55)	(-3.90)	(33.37)	(-4.15)	(1.67)	(2.65)

Table 5.4. Linear and Non-Linear Cointegration Tests of Sovereign Default Risk via PCV

This table shows results of linear and non-linear cointegration tests of the sovereign default risk via functional coefficients of investment sentiment using PCV. Each regression tests the relationship of sovereign default risk between Germany and one of other European countries. Panel A shows the variables that can be linear cointegrated, and the ADF *p*-values and the linear coefficients are displayed with *t*-values in parentheses.
Panel B uses the following functional coefficient model:

$$cds_{Sov,t} = f_0(sent_{t-1}) + f_1(sent_{t-1})cds_{de,t} + u_t \,,$$

$$cds_{de,t} = cds_{de,t-1} + v_t \,.$$

In Panel B, variables cannot be linear cointegrated while their optimal *k* is two in the semiparametric specifications. The linear coefficients are showed for comparison. The functional coefficients of investor sentiment under the two bins (*k*=2) are showed separately.

Panel A: Linear Cointegrated			
Country	Linear adf	Linear coefficients	
	p-value	α_0	α_1
Austria	0.01	-5.41***	2.33***
		(-11.96)	(136.82)
Sweden	0.08	9.85***	0.99***
		(9.97)	(33.34)

Panel B: Functional Cointegrated with Optimal k=2							
	Linear			Non-linear			
Country	Linear adf	Linear coefficients		Optimal *k*	AIC adf	Functional coefficients	
	p-value	α_0	α_1		*p*-value	f_0	f_1
Italy	0.24	43.99***	4.23***	2	0.00	31.13	4.03
		(10.54)	(33.15)			24.57	5.03
Netherlands	0.34	5.22***	1.59***	2	0.00	5.83	1.56
		(7.18)	(68.91)			7.97	1.57
UK	0.18	12.08***	1.47***	2	0.00	13.66	1.40
		(17.16)	(71.34)			14.25	1.30

Table 5.5. Linear and Non-Linear Cointegration Tests of Sovereign Default Risk via CCI

This table shows results of linear and non-linear cointegration tests of the sovereign default risk via functional coefficients of investment sentiment using PCO. Each regression tests the relationship of sovereign default risk between Germany and one of other European countries. Panel A shows the variables that can be linear cointegrated, and the ADF *p*-values and the linear coefficients are displayed with *t*-values in parentheses.

Panel B uses the following functional coefficient model:

$$cds_{Sov,t} = f_0(sent_{t-1}) + f_1(sent_{t-1})cds_{de,t} + u_t \,,$$

$$cds_{de,t} = cds_{de,t-1} + v_t \,.$$

In Panel B, variables cannot be linear cointegrated while their optimal *k* is two in the semiparametric specifications. The linear coefficients are showed for comparison. The functional coefficients of investor sentiment under the two bins (*k*=2) are showed separately.

Panel C shows the variables that cannot be linear cointegrated while their optimal *k* is larger than two. Polynomial regressions of investor sentiment with the following expressions are applied:

$$\hat{f}_0(sent_{t-1}) = \beta_{0,0} + \beta_{0,1}sent_{t-1} + \beta_{0,2}sent_{t-1}^2 + \beta_{0,2}sent_{t-1}^3 + v_{0,t} \,,$$

$$\hat{f}_1(sent_{t-1}) = \beta_{1,0} + \beta_{1,1}sent_{t-1} + \beta_{1,2}sent_{t-1}^2 + \beta_{1,2}sent_{t-1}^3 + v_{1,t} \,.$$

The polynomial coefficients of the functional specifications are displayed with t-values in parentheses.

Panel A: Linear Cointegrated			
Country	Linear adf *p*-value	Linear coefficients α_0	α_1
Austria	0.05	-6.78***	2.36***
		(-8.94)	(98.10)
Sweden	0.03	10.87***	0.97***
		(12.69)	(35.69)

Table 5.5 (*continued*)

Panel B: Functional Cointegrated with Optimal k>2														
		Linear		Non-linear										
Country	Linear adf *p*-value	Linear coefficients		Optimal *k*	AIC adf *p*-value	Polynomial coeff. of *f*(0) *t*-stats. in parentheses				Polynomial coeff. of *f*(1) *t*-stats. in parentheses				
		α_0	α_1			$\beta_{0,0}$	$\beta_{0,1}$	$\beta_{0,2}$	$\beta_{0,3}$	$\beta_{1,0}$	$\beta_{1,1}$	$\beta_{1,2}$	$\beta_{1,3}$	
Belgium	0.19	-4.97***	3.16***	47	0.00	29.59***	-1.86	-0.22	-0.10**	2.23***	0.29***	-0.01***	-0.01**	
		(-3.52)	(70.70)			(12.54)	(-1.47)	(-1.54)	(-2.04)	(35.29)	(8.61)	(-2.63)	(-5.91)	
Denmark	0.33	-3.55***	1.74***	47	0.00	-11.21***	0.59	0.54***	-0.01	2.13***	-0.14***	-0.04***	0.00***	
		(-4.42)	(68.39)			(-10.63)	(1.61)	(12.30)	(-1.36)	(41.53)	(-7.60)	(-17.71)	(6.53)	
France	0.15	2.88***	1.79***	42	0.00	18.35***	-4.36***	-0.18***	0.05***	1.36***	0.12***	0.01***	-0.00***	
		(3.71)	(72.65)			(16.37)	(-13.03)	(-4.17)	(6.94)	(29.29)	(8.58)	(4.64)	(-7.26)	
Italy	0.25	35.34***	4.45***	47	0.00	84.56***	-15.20***	-0.52***	0.13***	3.05***	-0.01	0.06***	0.00	
		(9.59)	(38.06)			(20.42)	(-10.45)	(-3.75)	(4.61)	(15.48)	(-0.11)	(9.46)	(0.58)	
Netherlands	0.34	5.30***	1.59***	47	0.00	13.66***	-1.41***	0.02***	0.01***	1.28***	0.01	-0.00**	-0.00***	
		(7.23)	(68.44)			(18.65)	(-7.94)	(2.91)	(5.56)	(54.53)	(1.57)	(-2.16)	(-4.89)	
Spain	0.24	48.46***	3.99***	47	0.00	93.80***	0.03	-0.85***	0.00	5.29***	-0.04	-0.01	0.00***	
		(13.00)	(33.72)			(14.52)	(0.02)	(-5.44)	(0.07)	(24.57)	(-0.77)	(-1.61)	(2.76)	
UK	0.18	12.11***	1.47***	47	0.00	23.53***	1.63***	-0.33***	-0.01	1.18***	-0.04***	0.01***	-0.00	
						(23.38)	(5.12)	(-11.49)	(-1.61)	(27.62)	(-2.67)	(11.15)	(-1.16)	

CHAPTER SIX:
CONCLUSION

6. Conclusion

This thesis investigates how credit default risk as reflected in credit default swap (CDS) spread is transferred in the European countries. The first empirical section analyses the default risk transfer between the sovereign and the financial institutions' CDS series during the European sovereign debt crisis in 2010. The results show that before the first Greek bailout by the EFSF in May 2010, two-way feedback effects exist between the two sectors in both the short and the long runs. After the first Greek bailout, the shocks in the financial institutions' CDS spreads either exert significantly negative impacts on the sovereign CDS spreads or lose their influences.

The study further analyses the effect of default risk transfer in Greece (the second bailout), Ireland and Portugal, and set sub-periods according to the bailouts to these three countries by the EFSF. The findings show that the transmissions of default risk from the financial sector to sovereign debt in each of the three countries are insignificant both before and after each of the bailouts. The default risk transfer is significant only when the first Greek bailout was issued. The transmission of default risk disappeared when the other countries requested for their own bailouts. This is defined as the "Greek effect" in this study. The implication of the findings is that the first bailout by the EFSF to Greece helps alleviate the financial systemic risk and break the private-to-public risk transfer. Since the investors perceived the forthcoming bailouts to the GIIPS countries, the EFSF has actually become the central bank of the whole Eurozone, and the default risk dropped in one single country will be shared in the long term by all the Eurozone countries.

There are limitations to the EFSF bailout programme, as the EFSF raises funds only after an official aid request is made by a country. The EFSF funds are given to the governments, which in turn bailout individual institutions in the country, leading increases in the government default risk. The EFSF has been improved to the

European Stability Mechanism (ESM), a permanent bailout funding programme, and the current Spanish bailout has been passed on to the ESM in early 2013. The funds by the ESM are transferred in the form of ESM notes to individual banks through FROB, and these banks have been confirmed to receive certain amounts according to the bailout scheme. Further research could also be focused on the Spanish case in order to make comparison of different bailout policies.

Following the study in Chapter 3, Chapter 4 applies the bivariate VEC model with a threshold effect to test the cointegration of the default risk of the sovereign and financial sectors for the GIIPS countries in two regimes, i.e., typical and atypical regimes. The results show that this model is able to detect structural breaks in the cointegration relationship between the sovereign and the financial sectors, and the structural breaks (atypical regime) are mainly found around the global credit crunch period (2007-2008) and the Eurozone crisis (since early 2010).

The study further analyses the impulse responses between the sovereign default risk and the default risk of the financial institutions in the typical and atypical regimes. For the countries except Greece, positive interdependencies exist between the default risk of the sovereign and financial sectors. Importantly, the positive responses between the two sectors become stronger in the atypical regime, which implies that the sensitivity of the sovereign default risk to the default risk of the financial institutions is higher, and vice versa. For Greece, however, the results indicate that in the typical regime, only the impacts of the sovereign default risk on the default risk of the domestic financial sectors are positively significant. In the atypical regime, the public-to-private impacts become insignificant, and more importantly, the default risk of the financial institutions has negatively significant impact on the sovereign default risk. The implication of the findings is that the different pattern of the results across countries is due to the financial situation of the countries at the beginning of the financial crisis. For Greece, since the negative force is stronger than the positive force in the default risk transfer from the financial sector to the sovereign sector in the atypical regime, the overall sensitivity of the sovereign default risk to a shock in the financial institutions is negative.

Chapter 5 uses the semiparametric models introduced by Banerjee and Pitarakis (2013) to analyse the cointegrated relationship of sovereign default risk of the European countries, and the functional coefficients of the relationship are regressions on an investor sentiment variable. Three measures of investor sentiment are applied, which are Consumer Confidence Indicator (CCI), put-call trading volume ratio (PCV) and put-call open interest ratio (PCO).

The results show that when the variables cannot be linear cointegrated, the functional cointegration are more suitable for the data. The functional coefficients are able to capture the structural features or the regimes shifts. The results indicate that in the typical regime, the default risk of the underlying country is lower and more stable, suggesting lower gap to the default risk of the benchmark country; the response of the underlying country is quick in order to close the gap between the two countries. During the crisis periods, however, the CDS spread of the underlying country can rise sharply in the short term, causing the trench of default risk further widen between the country and the benchmark; the adjustment speed is slower compared to that in the typical regime, indicating that it is more difficult for the country to close this gap.

The implication of this thesis is twofold. First, the thesis provides a robust methodology for researchers and analysts in this area such as stress tests of institutions to test the default risk transfer between the public and private sectors, or among countries. The results from this thesis show that for the European countries, especially for the Eurozone countries, targeted bailout policies are cable to break the two-way feedback effect between sectors and realise the transfer of default risk.

Second, it is possible to observe or to predict the regime shift in the cointegration relationship of the sovereign default risk of the two countries by using investor sentiment indices of two countries, for example, one stable market (Germany), and one riskier country. Although this prediction is in the short run, since the thesis uses daily data, the methodology of using functional coefficients of investor sentiment is applicable for the analysis of data with low frequency (for example, annual data with longer period) or other markets rather than the Europe.

APPENDICES

Appendix 1
EFSF Guarantee Commitments

The commitments are made in accordance with the share of the guarantee countries in the paid-up capital of the European Central Bank.

	New EFSF Guarantee Commitments (€m)	New EFSF contribution key (%)	EFSF Amended Guarantee Commitments (€m)	EFSF amended contribution key (%)
Austria	21,639	2.78	21,639	2.99
Belgium	27,032	3.47	27,032	3.72
Cyprus	1,526	0.20	1,526	0.21
Estonia	1,995	0.26	1,995	0.27
Finland	13,974	1.79	13,974	1.92
France	158,488	20.31	158,488	21.83
Germany	211,046	27.06	211,046	29.07
Greece	21,898	2.81	-	0.00
Ireland	12,378	1.59	-	0.00
Italy	139,268	17.86	139,268	19.18
Luxembourg	1,947	0.25	1,947	0.27
Malta	704	0.09	704	0.10
Netherlands	44,446	5.70	44,446	6.12
Portugal	19,507	2.50	-	0.00
Slovakia	7,728	0.99	7,728	1.06
Slovenia	3,664	0.47	3,664	0.51
Spain	92,544	11.87	92,544	12.75
Total	779,738	100	726,000	100

Source: The EFSF FAQ Update 2012. http://www.efsf.europa.eu/attachments/faq_en.pdf

Appendix 2
EFSF Lending Operations to Greece (Second Bailout), Ireland and Portugal

Beneficiary country	Date of disbursement	Amount disbursed	Maturity
Ireland	01/02/2011	€3.6 billion	18/07/2016
	10/11/2011	€3 billion	04/02/2022
	15/12/2011	€1 billion	23/08/2012
	12/01/2012	€1.2 billion	04/02/2015
	19/01/2012	€0.5 billion	19/07/2012
	03/04/2012	€2.7 billion	03/04/2037
Portugal	22/06/2011	€3.7 billion	05/07/2021
	29/06/2011	€2.2 billion	05/12/2016
	20/12/2011	€1 billion	23/08/2012
	12/01/2012	€1.7 billion	04/02/2015
	19/01/2012	€1 billion	19/07/2012
	30/05/2012	€5.2 billion	30/05/2032
	17/07/2012	€2.6 billion	17/07/2038
Greece			
PSI	various dates	€29.7 billion	24/02/2042
Accrued interest	various dates	€4.8 billion	28/08/2037
2nd progr. - Tranche 1	19/03/2012	€5.9 billion	19/03/2032
2nd progr. - Tranche 2	10/04/2012	€3.3 billion	10/04/2027
2nd progr. - Tranche 3 (Bank recapitalisation)	19/04/2012	€25 billion	19/04/2032
2nd progr. - Tranche 4	10/05/2012	€4.2 billion	10/05/2027
2nd progr. - Tranche 5	28/06/2012	€1 billion	28/06/2027

Source: *http://www.efsf.europa.eu/about/operations/index.htm*

Appendix 3

The CDS series of both the sovereign debts and the financial institutions are issued in Euro. In Panel B, CDS series in bold are the financial sector constituents of the iTraxx Europe index.

Panel A. List of CDS Series of Sovereign Debts

No	Market	Code	Name
1	Austria	at	REPUBLIC OF AUSTRIA
2	Belgium	be	KINGDOM OF BELGIUM
3	France	fr	FRENCH REPUBLIC
4	Germany	de	FEDERAL REP GERMANY
5	Greece	gr	HELLENIC REPUBLIC
6	Ireland	ie	IRELAND
7	Italy	it	REPUBLIC OF ITALY
8	Netherlands	nl	KINGDOM OF NETHERLANDS
9	Portugal	pt	REPUBLIC OF PORTUGAL
10	Spain	es	KINGDOM OF SPAIN

Appendix 3 *(continued)*

Panel B. List of CDS Series of Financial Institutions			
No	Market	Code	Name
1	Austria	rzb	RAIF. ZNTRLBK. OSTER AG
2	Austria	ers	ERSTE GROUP BANK AG
3	Belgium	kbc	KBC GROUP NV
4	**France**	**bnp**	**BNP PARIBAS**
5	**France**	**car**	**CREDIT AGRICOLE SA**
6	**France**	**sge**	**SOCIETE GENERALE SA**
7	France	cnt	NATIXIS
8	France	axa	AXA
9	France	sco	SCOR SA
10	France	gfc	GECINA SA
11	France	wed	WENDEL INVESTI
12	**Germany**	**ikb**	**ALLIANZ SE**
13	**Germany**	**dbk**	**COMMERZBANK AG**
14	**Germany**	**cbg**	**DEUTSCHE BANK AG**
15	**Germany**	**muv**	**HANNOVER RUCK.AG**
16	Germany	alv	IKB DT.INDUSTR.BANK AG
17	Germany	hnr	MUNICH REINSURANCE CO
18	Greece	aca	ALPHA BANK A.E.
19	Ireland	aib	ALLIED IRISH BANKS
20	Ireland	bki	BANK OF IRELAND
21	Ireland	ipm	IRISH LIFE & PERM
22	**Italy**	**bci**	**INTESA SANPAOLO SPA**
23	Italy	mdb	MEDIOBANCA SPA
24	**Italy**	**bmp**	**BANCA MDP DI SIENA SPA**
25	Italy	pii	BCA PPO MILANO SOCO ARL
26	**Italy**	**uni**	**UNICREDITO ITALIANO SPA**
27	Italy	ubi	UNIONE DI BANCHE
28	Italy	gas	ASSIC GENI - SO PER AZN
29	Netherlands	abn	ABN AMRO BANK NV
30	**Netherlands**	**aen**	**AEGON NV**
31	Netherlands	ina	ING VERZEKERINGEN NV
32	Netherlands	inb	ING BANK NV
33	Netherlands	sns	SNS BANK
34	Portugal	bcp	BANCO COMR.PORTUGUES
35	Portugal	bes	BANCO ESPIRITO SANTO SA
36	**Spain**	**bbv**	**BANCO BILBAO VIZCAYA ARG**
37	Spain	bkt	BANKINTER SA
38	Spain	pop	BANCO POPOLAR ESPN. SA
39	Spain	sab	BANCO SABADELL SA
40	**Spain**	**san**	**BANCO STDR.CTL.HISP. SA**

Appendix 4
Summary Statistics of CDS Spreads of Ten EFSF Guarantee Countries

This table shows the means, minimum values, maximum values and standard deviations of the CDS spreads with Euro denomination in basis points. The time series start from 13 November 2007 until 17 February 2012.The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions.

Market	Variable	Mean	Min	Max	SD
Austria	at	66.63	2.50	265.00	56.66
	rzb	190.70	75.00	525.00	93.51
	ers	163.60	13.70	475.00	86.35
Belgium	be	48.95	5.60	158.00	32.22
	kbc	154.30	41.00	350.00	78.18
France	fr	31.67	4.50	96.50	21.49
	bnp	65.61	27.00	139.20	19.18
	car	87.35	35.00	217.30	22.69
	sge	88.52	29.00	197.80	23.40
	cnt	180.50	49.00	350.00	82.83
	axa	116.40	50.60	271.60	50.69
	sco	86.11	34.00	202.50	39.02
	gfc	553.60	172.40	1722.00	368.10
	wed	532.20	59.20	1198.00	278.30
Germany	de	26.01	3.30	92.50	19.14
	ikb	537.20	78.20	1400.00	348.80
	dbk	94.63	37.00	180.40	27.48
	cbg	84.37	39.10	165.50	24.40
	muv	53.43	25.50	126.50	17.60
	alv	79.06	43.00	192.50	27.29
	hnr	67.43	31.00	146.70	22.12
Greece	gr	158.70	10.00	1012.00	140.30
	aca	264.60	28.39	946.50	204.60

(Continued)

Appendix 4 *(continued)*

Market	Variable	Mean	Min	Max	SD
Ireland	ie	125.30	7.60	390.00	90.44
	aib	222.00	60.00	675.00	125.30
	bki	231.00	60.00	662.50	129.40
	ipm	224.70	71.20	575.00	99.07
Italy	it	85.37	10.10	235.00	49.55
	bci	74.59	30.54	200.00	31.37
	mdb	85.06	35.00	170.70	36.51
	bmp	85.97	41.50	207.60	26.76
	pii	82.92	41.60	168.30	31.18
	uni	99.48	42.00	280.00	39.15
	ubi	91.19	13.00	185.00	33.99
	gas	82.69	43.00	203.30	30.96
Netherlands	nl	36.54	3.90	130.00	30.44
	abn	92.88	44.80	187.50	27.75
	aen	200.50	52.00	563.30	115.50
	ina	129.80	8.10	370.00	74.79
	inb	89.92	38.30	185.50	30.75
	sns	232.40	11.50	575.00	151.10
Portugal	pt	77.12	9.00	466.50	57.64
	bcp	108.50	40.50	534.10	54.98
	bes	125.30	48.00	562.10	57.65
Spain	es	76.08	6.80	260.40	42.82
	bbv	93.68	37.00	256.70	30.81
	bkt	148.80	14.79	309.00	101.70
	pop	166.00	14.79	369.10	94.31
	sab	203.60	76.40	403.80	73.49
	san	96.25	38.80	242.80	30.17

Appendix 5
Unit Root Test for the Ten Countries before and after the First Greek Bailout

This table shows the results of the ADF tests for the series of CDS spreads in log-level, and difference in log-level. 12 lags are included for all the series.

Panel A. Before first Greek bailout					
		ln(var)		Δ*ln*(var)	
	var	t-stat	p-value	t-stat	p-value
Austria	at	-1.27	0.89	-6.33	0.00
	rzb	-1.72	0.74	-7.15	0.00
	ers	-3.08	0.11	-7.56	0.00
Belgium	be	-2.04	0.58	-6.12	0.00
	kbc	-1.65	0.77	-5.96	0.00
Greece	gr	-1.88	0.67	-5.23	0.00
	aca	-1.56	0.81	-7.06	0.00
Ireland	ie	-1.70	0.75	-6.54	0.00
	aib	-2.31	0.43	-5.97	0.00
	bki	-2.39	0.39	-6.17	0.00
	ipm	-2.53	0.31	-6.24	0.00
Italy	it	-2.10	0.55	-5.91	0.00
	bci	-1.91	0.65	-7.14	0.00
	mdb	-1.64	0.78	-6.16	0.00
	bmp	-2.38	0.39	-6.93	0.00
	pii	-2.00	0.60	-6.34	0.00
	uni	-2.28	0.44	-6.91	0.00
	ubi	-4.57	0.00	-6.88	0.00
	gas	-2.19	0.50	-6.23	0.00
Portugal	pt	-1.65	0.77	-5.33	0.00
	bcp	-1.71	0.75	-5.67	0.00
	bes	-2.51	0.32	-5.42	0.00
Spain	es	-2.12	0.54	-6.95	0.00
	bbv	-2.47	0.35	-7.08	0.00
	bkt	-1.82	0.70	-6.95	0.00
	pop	-1.68	0.76	-6.81	0.00
	sab	-2.22	0.48	-5.21	0.00
	san	-2.43	0.36	-7.12	0.00

	var	*ln*(var) t-stat	*ln*(var) p-value	Δ*ln*(var) t-stat	Δ*ln*(var) p-value
France	fr	-1.91	0.65	-6.32	0.00
	bnp	-2.99	0.13	-6.30	0.00
	car	-3.14	0.10	-5.46	0.00
	sge	-3.26	0.07	-5.31	0.00
	cnt	-2.18	0.50	-5.83	0.00
	axa	-2.20	0.49	-5.78	0.00
	sco	-2.13	0.53	-6.07	0.00
	gfc	-1.51	0.83	-5.90	0.00
	wed	-2.85	0.18	-5.54	0.00
Germany	de	-1.58	0.80	-6.48	0.00
	ikb	-1.95	0.63	-5.84	0.00
	dbk	-2.56	0.30	-6.79	0.00
	cbg	-2.90	0.16	-5.94	0.00
	muv	-2.40	0.38	-6.71	0.00
	alv	-2.34	0.41	-7.35	0.00
	hnr	-2.38	0.39	-6.83	0.00
Netherlands	nl	-1.47	0.84	-6.05	0.00
	abn	-3.48	0.04	-6.49	0.00
	aen	-2.24	0.47	-5.93	0.00
	ina	-3.14	0.10	-6.15	0.00
	inb	-2.85	0.18	-6.19	0.00
	sns	-3.49	0.04	-6.27	0.00

Panel B. After first Greek bailout

	var	*ln*(var) t-stat	*ln*(var) p-value	Δ*ln*(var) t-stat	Δ*ln*(var) p-value
Austria	at	-1.49	0.83	-6.11	0.00
	rzb	-1.59	0.80	-5.20	0.00
	ers	-1.58	0.80	-5.48	0.00
Belgium	be	-2.17	0.51	-6.20	0.00
	kbc	-2.57	0.29	-5.15	0.00
Greece	gr	-1.83	0.69	-5.59	0.00
	aca	-2.04	0.58	-4.14	0.00
Ireland	ie	-0.64	0.98	-6.82	0.00
	aib	-1.60	0.79	-6.66	0.00
	bki	-1.08	0.93	-6.12	0.00
	ipm	-0.39	0.99	-6.18	0.00

	var	*ln*(var) t-stat	*ln*(var) p-value	Δ*ln*(var) t-stat	Δ*ln*(var) p-value
Italy	it	-1.88	0.67	-6.69	0.00
	bci	-1.97	0.62	-5.63	0.00
	mdb	-2.01	0.60	-5.02	0.00
	bmp	-2.03	0.59	-5.67	0.00
	pii	-1.74	0.73	-5.36	0.00
	uni	-2.21	0.49	-5.39	0.00
	ubi	-1.66	0.77	-5.33	0.00
	gas	-2.30	0.43	-5.43	0.00
Portugal	pt	-2.78	0.20	-6.38	0.00
	bcp	-2.10	0.54	-5.14	0.00
	bes	-2.61	0.27	-5.47	0.00
Spain	es	-2.61	0.28	-6.71	0.00
	bbv	-2.88	0.17	-6.16	0.00
	bkt	-1.12	0.93	-5.56	0.00
	pop	-1.94	0.64	-4.32	0.00
	sab	-1.85	0.68	-4.32	0.00
	san	-2.87	0.17	-6.85	0.00
France	fr	-1.76	0.72	-6.54	0.00
	bnp	-1.90	0.65	-6.92	0.00
	car	-2.44	0.36	-6.82	0.00
	sge	-2.05	0.57	-6.28	0.00
	cnt	-1.87	0.67	-6.54	0.00
	axa	-2.34	0.41	-4.97	0.00
	sco	-1.80	0.71	-6.22	0.00
	gfc	-1.82	0.69	-5.23	0.00
	wed	-1.86	0.68	-4.80	0.00
Germany	de	-2.03	0.58	-5.92	0.00
	ikb	-2.02	0.59	-7.14	0.00
	dbk	-2.34	0.41	-6.20	0.00
	cbg	-2.60	0.28	-6.27	0.00
	muv	-3.41	0.05	-6.17	0.00
	alv	-2.68	0.25	-6.34	0.00
	hnr	-2.06	0.57	-6.43	0.00
Netherlands	nl	-1.48	0.84	-5.36	0.00
	abn	-2.72	0.23	-7.50	0.00
	aen	-2.30	0.44	-5.74	0.00
	ina	-1.86	0.68	-5.74	0.00
	inb	-2.17	0.50	-5.62	0.00
	sns	-1.91	0.65	-5.75	0.00

Appendix 6
Cointegration Tests for the Ten Countries before and after the First Greek Bailout

This table shows the results from the Johansen tests statistics. The respective null hypothesis is that the maximum cointegrating rank is 0 or 1. The optimal lag length is shown.

Panel A. Before first Greek bailout							
country	variables		lags	r=0		r=1	
				eigenvalue	trace stat	eigenvalue	trace stat
Austria	at	rzb	6	**.**	**14.79**	0.02	4.04
	at	ers	5	.	13.73	0.02	1.84
Belgium	be	kbc	10	**.**	**13.04**	0.01	5.78
Greece	gr	aca	2	**.**	**6.82**	0.01	1.00
Ireland	ie	aib	9	.	29.73	0.04	4.50
	ie	bki	2	**.**	**14.42**	0.02	4.05
	ie	ipm	2	**.**	**11.64**	0.01	4.04
Italy	it	bci	2	.	19.21	0.02	7.58
	it	mdb	2	**.**	**11.33**	0.01	4.22
	it	bmp	2	.	20.50	0.02	7.55
	it	pii	2	**.**	**13.69**	0.01	5.50
	it	uni	3	.	26.23	0.03	6.21
	it	ubi	1	.	26.53	0.03	3.82
	it	gas	2	.	16.40	0.01	6.71
Portugal	pt	bcp	2	**.**	**12.22**	0.02	2.31
	pt	bes	2	**.**	**11.82**	0.01	3.11
Spain	es	bbv	2	.	20.86	0.02	8.22
	es	bkt	1	.	19.00	**0.03**	**2.52**
	es	pop	1	**.**	**11.89**	0.01	3.04
	es	sab	2	**.**	**13.86**	0.01	5.86
	es	san	2	.	19.43	0.02	7.71
France	fr	bnp	2	.	16.43	0.02	3.96
	fr	car	2	**.**	**13.99**	0.02	3.41
	fr	sge	2	**.**	**13.61**	0.02	3.47
	fr	cnt	2	**.**	**6.75**	0.01	2.49
	fr	axa	3	**.**	**7.16**	0.01	1.96
	fr	sco	2	**.**	**6.64**	0.01	1.61
	fr	gfc	2	**.**	**4.54**	0.01	0.86
	fr	wed	5	.	17.25	**0.02**	**1.65**
Germany	de	ikb	2	**.**	**8.11**	0.01	0.94
	de	dbk	2	**.**	**15.03**	0.02	2.84
	de	cbg	2	**.**	**13.23**	0.02	2.93
	de	muv	2	**.**	**10.48**	0.01	2.77
	de	alv	2	**.**	**12.22**	0.02	2.25
	de	hnr	3	**.**	**10.64**	0.01	2.72

country	variables		lags	r=0		r=1	
				eigenvalue	trace stat	eigenvalue	trace stat
Netherlands	nl	abn	2	.	**12.47**	0.01	3.76
	nl	aen	2	.	**9.24**	0.01	4.41
	nl	ina	2	.	**13.71**	0.02	2.77
	nl	inb	2	.	**12.39**	0.01	4.14
	nl	sns	4	.	20.91	**0.03**	**3.17**

Panel B. After first Greek bailout							
country	variables		lags	r=0		r=1	
				eigenvalue	trace stat	eigenvalue	trace stat
Austria	at	rzb	4	.	**14.20**	0.03	1.11
	at	ers	4	.	22.43	**0.05**	**0.53**
Belgium	be	kbc	4	.	18.67	**0.03**	**3.50**
Greece	gr	aca	2	.	**6.66**	0.01	0.21
Ireland	ie	aib	8	.	**14.59**	0.02	5.17
	ie	bki	2	.	20.90	0.03	6.61
	ie	ipm	2	.	28.32	0.05	6.46
Italy	it	bci	2	.	**10.29**	0.02	1.52
	it	mdb	3	.	19.16	**0.04**	**1.31**
	it	bmp	3	.	**8.69**	0.01	1.96
	it	pii	3	.	**8.99**	0.02	1.12
	it	uni	3	.	**7.93**	0.01	1.56
	it	ubi	3	.	**10.91**	0.02	1.72
	it	gas	3	.	**8.97**	0.02	1.90
Portugal	pt	bcp	4	.	**7.67**	0.01	2.10
	pt	bes	4	.	**8.19**	0.01	1.54
Spain	es	bbv	4	.	21.53	0.03	6.39
	es	bkt	2	.	24.16	**0.05**	**2.60**
	es	pop	2	.	45.47	**0.09**	**2.12**
	es	sab	6	.	**12.15**	0.02	2.31
	es	san	4	.	18.68	0.03	5.33
France	fr	bnp	4	.	**9.84**	0.02	1.54
	fr	car	4	.	**14.11**	0.02	2.49
	fr	sge	4	.	**12.65**	0.02	1.47
	fr	cnt	2	.	27.34	**0.05**	**3.44**
	fr	axa	2	.	18.45	**0.03**	**2.25**
	fr	sco	2	.	**13.49**	0.02	1.94
	fr	gfc	2	.	**10.63**	0.02	2.52
	fr	wed	2	.	**6.97**	0.01	1.38

country	variables	lags		r=0		r=1	
				eigenvalue	trace stat	eigenvalue	trace stat
Germany	de	ikb	2	.	**15.07**	0.03	1.14
	de	dbk	2	.	**8.80**	0.02	1.21
	de	cbg	2	.	**10.63**	0.02	1.38
	de	muv	4	.	**8.40**	0.02	0.79
	de	alv	4	.	**12.82**	0.03	0.77
	de	hnr	4	.	**9.44**	0.02	0.77
Netherlands	nl	abn	2	.	**11.59**	0.02	0.88
	nl	aen	2	.	**15.06**	0.03	1.05
	nl	ina	2	.	**9.90**	0.02	0.00
	nl	inb	2	.	**13.93**	0.03	1.94
	nl	sns	2	.	24.01	**0.05**	**0.98**

Appendix 7
Granger Causality Tests for the Countries before and after the First Greek Bailout

This table shows the results from the Granger causality tests after the estimated VEC models (if the variables can be cointegrated). The null hypothesis is that the dependant variable is Granger caused by the indipendant variable.

Panel A. Before first Greek bailout						
country	sovereign-to-financial			financial-to-sovereign		
	dep.var	indep.var	p-value	dep.var	indep.var	p-value
Austria	at	rzb	0.00	rzb	at	0.00
	at	ers	0.00	ers	at	0.00
Belgium	be	kbc	0.04	kbc	be	0.00
Greece	gr	aca	0.78	aca	gr	0.29
Ireland	ie	aib	-	aib	ie	-
	ie	bki	0.00	bki	ie	0.13
	ie	ipm	0.00	ipm	ie	0.01
Italy	it	bci	-	bci	it	-
	it	mdb	0.00	mdb	it	0.00
	it	bmp	-	bmp	it	-
	it	pii	0.00	pii	it	0.11
	it	uni	-	uni	it	-
	it	ubi	-	ubi	it	-
	it	gas	-	gas	it	-
Portugal	pt	bcp	0.00	bcp	pt	0.00
	pt	bes	0.01	bes	pt	0.00
Spain	es	bbv	-	bbv	es	-
	es	bkt	-	bkt	es	-
	es	pop	-	pop	es	-
	es	sab	0.00	sab	es	0.00
	es	san	-	san	es	-
France	fr	bnp	-	bnp	fr	-
	fr	car	0.09	car	fr	0.56
	fr	sge	0.00	sge	fr	0.14
	fr	cnt	0.01	cnt	fr	0.53
	fr	axa	0.80	axa	fr	0.00
	fr	sco	0.84	sco	fr	0.01
	fr	gfc	0.28	gfc	fr	0.19
	fr	wed	0.64	wed	fr	0.54
Germany	de	ikb	0.84	ikb	de	0.14
	de	dbk	0.06	dbk	de	0.10
	de	cbg	0.00	cbg	de	0.43
	de	muv	0.19	muv	de	0.01
	de	alv	0.32	alv	de	0.02
	de	hnr	0.64	hnr	de	0.15

country	sovereign-to-financial			financial-to-sovereign		
	dep.var	indep.var	p-value	dep.var	indep.var	p-value
Netherlands	nl	abn	0.10	abn	nl	0.16
	nl	aen	0.04	aen	nl	0.77
	nl	ina	0.01	ina	nl	0.02
	nl	inb	0.01	inb	nl	0.02
	nl	sns	0.00	sns	nl	0.43

Panel B. After first Greek bailout						
	sovereign-to-financial			financial-to-sovereign		
	dep.var	indep.var	p-value	dep.var	indep.var	p-value
Austria	at	rzb	0.04	rzb	at	0.04
	at	ers	0.01	ers	at	0.05
Belgium	be	kbc	0.00	kbc	be	0.01
Greece	gr	aca	0.01	aca	gr	0.00
Ireland	ie	aib	0.34	aib	ie	0.36
	ie	bki	-	bki	ie	-
	ie	ipm	-	ipm	ie	-
Italy	it	bci	0.05	bci	it	0.00
	it	mdb	0.04	mdb	it	0.00
	it	bmp	0.01	bmp	it	0.00
	it	pii	0.16	pii	it	0.00
	it	uni	0.28	uni	it	0.00
	it	ubi	0.01	ubi	it	0.00
	it	gas	0.04	gas	it	0.00
Portugal	pt	bcp	0.05	bcp	pt	0.00
	pt	bes	0.15	bes	pt	0.00
Spain	es	bbv	-	bbv	es	-
	es	bkt	0.04	bkt	es	0.00
	es	pop	0.34	pop	es	0.13
	es	sab	0.11	sab	es	0.01
	es	san	-	san	es	-
France	fr	bnp	0.00	bnp	fr	0.02
	fr	car	0.00	car	fr	0.01
	fr	sge	0.00	sge	fr	0.02
	fr	cnt	0.30	cnt	fr	0.03
	fr	axa	0.08	axa	fr	0.10
	fr	sco	0.22	sco	fr	0.15
	fr	gfc	0.28	gfc	fr	0.04
	fr	wed	0.54	wed	fr	0.00

	sovereign-to-financial			financial-to-sovereign		
	dep.var	indep.var	p-value	dep.var	indep.var	p-value
Germany	de	ikb	0.77	ikb	de	0.01
	de	dbk	0.31	dbk	de	0.39
	de	cbg	0.15	cbg	de	0.04
	de	muv	0.01	muv	de	0.01
	de	alv	0.20	alv	de	0.01
	de	hnr	0.03	hnr	de	0.01
Netherlands	nl	abn	0.14	abn	nl	0.00
	nl	aen	0.00	aen	nl	0.39
	nl	ina	0.46	ina	nl	0.00
	nl	inb	0.27	inb	nl	0.00
	nl	sns	0.00	sns	nl	0.73

Appendix 8
Summary Statistics of CDS Spreads of Greece

This table shows the means, minimum values, maximum values and standard deviations of the CDS spreads with Euro denomination in basis points. The time series start from 19 November 2009 until 08 October 2012. The Greek sovereign CDS spreads has remained unchanged, since Greek debt restructuring triggered approximately $3.2bn CDS credit protection payouts on Greek sovereign debt in early March 2012. Tests are not proceeded for the bailout and post-bailout periods during the second Greek bailout for collinearity problems. The two-letter variables indicate CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions.

Panel A. Whole period					
Variable	Mean	Min	Max	SD	Obs
aca	1339.41	225.00	2587.48	708.61	753
gr	4946.22	152.17	14911.74	5769.59	753
Panel B. First bailout					
Pre-bailout (19/11/2009-07/05/2010)					
Variable	Mean	Min	Max	SD	Obs
aca	422.45	225.00	946.45	151.71	122
gr	354.77	152.17	973.56	169.66	122
Bailout period (10/05/2010-20/07/2011)					
Variable	Mean	Min	Max	SD	Obs
aca	936.31	648.67	1520.19	163.44	313
gr	1038.94	486.13	2771.02	455.11	313
Panel C. Second bailout					
Pre-bailout (21/07/2011-20/02/2012)					
Variable	Mean	Min	Max	SD	Obs
aca	2186.19	1465.71	2587.48	335.16	153
gr	5893.73	1777.32	11453.91	2796.20	153
Bailout period (21/02/2012-28/06/2012)					
Variable	Mean	Min	Max	SD	Obs
aca	1986.79	1646.87	2472.28	317.97	93
gr	-	-	-	-	-
Post-bailout (29/06/2012-08/10/2012)					
Variable	Mean	Min	Max	SD	Obs
aca	2009.84	1478.08	2298.55	281.34	72
gr	-	-	-	-	-

Appendix 9
Summary Statistics of CDS Spreads of Ireland

This table shows the means, minimum values, maximum values and standard deviations of the CDS spreads with Euro denomination in basis points. The time series start from 19 November 2009 until 08 October 2012. The two-letter variables indicate CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions.

Panel A. Whole period					
Variable	Mean	Min	Max	SD	Obs
aib	1011.29	196.65	1812.99	483.75	753
bki	813.99	172.04	2298.98	475.05	753
ipm	936.78	154.65	2498.7	569.65	753
ie	459.7	96.92	1191.16	222.34	753
Panel B. Irish bailout					
Before application (19/11/2009-19/11/2010)					
Variable	Mean	Min	Max	SD	Obs
aib	380.1	196.65	999.72	173.64	262
bki	316.31	172.04	795.3	127.59	262
ipm	311.59	154.65	885.96	153.22	262
ie	222.7	96.92	556.38	113.13	262
Application period (22/11/2010-24/01/2011)					
Variable	Mean	Min	Max	SD	Obs
aib	1247.87	889.13	1461.34	229.74	46
bki	912.07	695.8	1126.78	122.32	46
ipm	956.49	753.21	1104.1	88.71	46
ie	539.61	476.45	603.75	27.76	46
Bailout period (25/01/2011-01/04/2012)					
Variable	Mean	Min	Max	SD	Obs
aib	1523.6	1068.12	1812.99	193.7	49
bki	1077.12	925	1248.84	84.39	49
ipm	1185.84	915	1447.52	157.82	49
ie	529.75	491.34	586.53	22.65	49
After bailout (04/04/2012-08/10/2012)					
Variable	Mean	Min	Max	SD	Obs
aib	1338.02	872.63	1351.21	68.34	396
bki	1099.32	594.36	2298.98	400.86	396
ipm	1317.31	910.02	2498.7	431.48	396
ie	598.55	222.95	1191.16	166.04	396

Appendix 10
Summary Statistics of CDS Spreads of Portugal

This table shows the means, minimum values, maximum values and standard deviations of the CDS spreads with Euro denomination in basis points. The time series start from 19 November 2009 until 08 October 2012. The two-letter variables indicate CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions.

Panel A. Whole period					
Variable	Mean	Min	Max	SD	Obs
bcp	786.15	69.73	1875.5	453.66	753
bes	667.66	97.41	1285.43	299.04	753
pt	606.34	61.17	1521.45	379.28	753
Panel B. Portugal bailout					
Before application (19/11/2009-06/04/2011)					
Variable	Mean	Min	Max	SD	Obs
bcp	416.94	69.73	900.55	238.85	360
bes	432.81	97.41	906.78	228.1	360
pt	266	61.17	521.84	116.83	360
Application period (07/04/2011-14/06/2011)					
Variable	Mean	Min	Max	SD	Obs
bcp	683.99	567.61	822.63	55.07	49
bes	640.59	520.29	752.79	49.83	49
pt	584.37	469.77	708.36	55.23	49
Bailout period (15/06/2011-17/07/2012)					
Variable	Mean	Min	Max	SD	Obs
bcp	1261.22	810.12	1875.5	260.55	285
bes	955.6	732.03	1285.43	116.87	285
pt	1042.24	702.41	1521.45	148	285
After bailout (18/07/2012-08/10/2012)					
Variable	Mean	Min	Max	SD	Obs
bcp	828.97	654.89	948.08	121.03	59
bes	732.23	543.47	866.86	117.87	59
pt	595.61	409.62	817.4	133.07	59

Appendix 11

Panel A. List of Sovereign CDS Series

No	Market	Code	Name
1	Greece	gr	HELLENIC REPUBLIC
2	Ireland	ie	IRELAND
3	Italy	it	REPUBLIC OF ITALY
4	Portugal	pt	REPUBLIC OF PORTUGAL
5	Spain	es	KINGDOM OF SPAIN

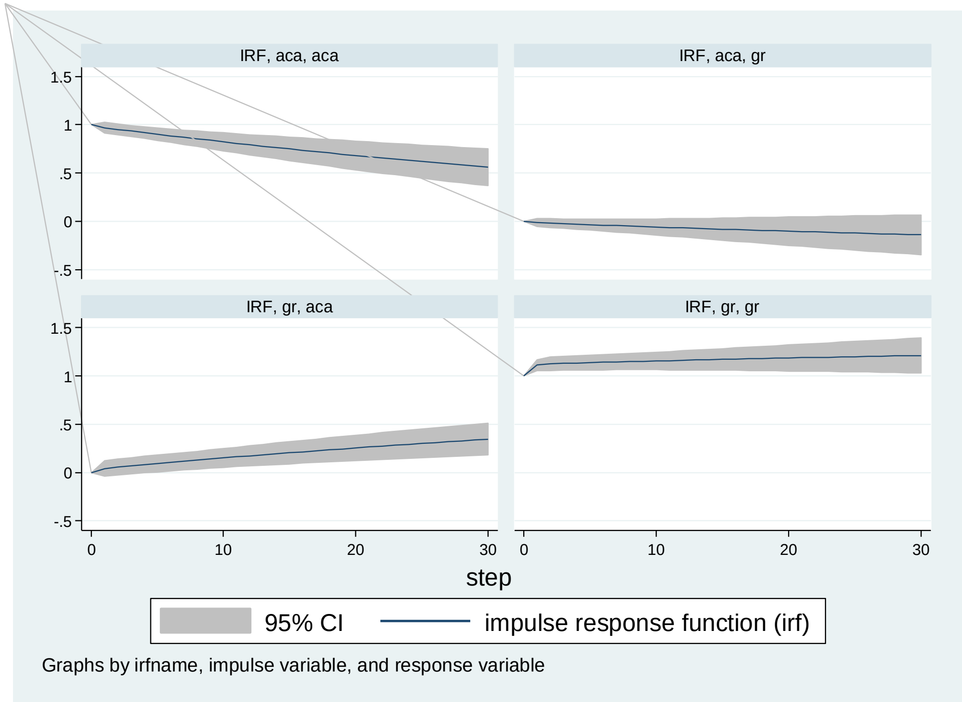
Panel B. List of CDS Series of Financial Institutions

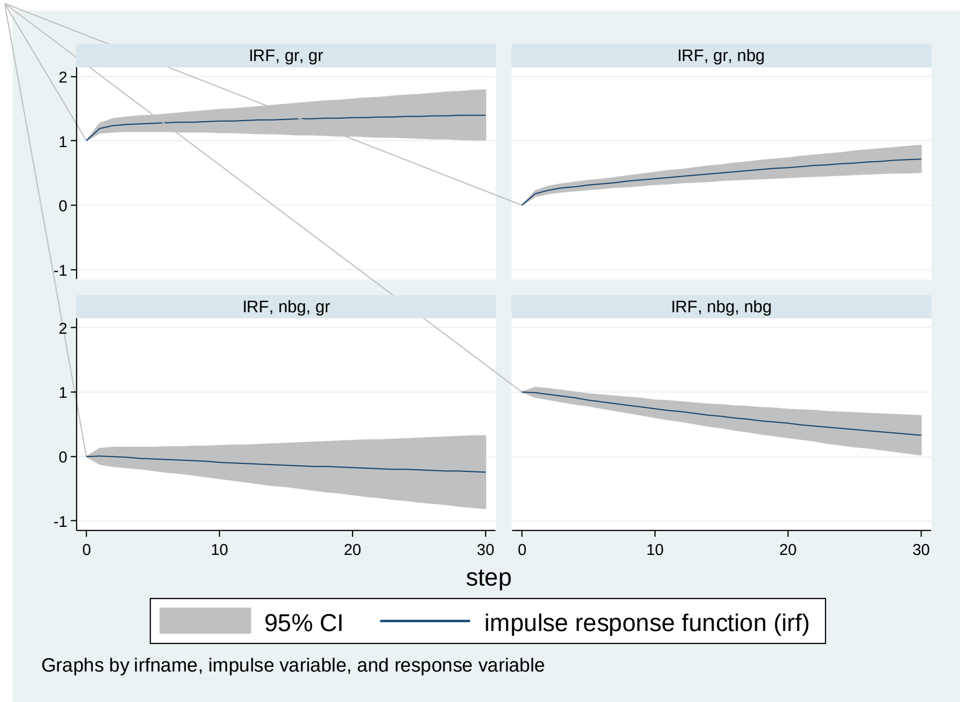
No	Market	Code	Name
1	Greece	aca	ALPHA BANK A.E.
2	Greece	nbg	NATIONAL BANK OF GREECE
3	Ireland	aib	ALLIED IRISH BANKS
4	Ireland	bki	BANK OF IRELAND
5	Ireland	ipm	IRISH LIFE & PERM
6	Italy	bci	INTESA SANPAOLO SPA
7	Italy	mdb	MEDIOBANCA SPA
8	Italy	bmp	BANCA MDP DI SIENA SPA
9	Italy	pii	BCA PPO MILANO SOCO ARL
10	Italy	uni	UNICREDITO ITALIANO SPA
11	Italy	ubi	UNIONE DI BANCHE
12	Italy	gas	ASSIC GENI - SO PER AZN
13	Portugal	bcp	BANCO COMR.PORTUGUES
14	Portugal	bes	BANCO ESPIRITO SANTO SA
15	Spain	bbv	BANCO BILBAO VIZCAYA ARG
16	Spain	bkt	BANKINTER SA
17	Spain	pop	BANCO POPOLAR ESPN. SA
18	Spain	sab	BANCO SABADELL SA
19	Spain	san	BANCO STDR.CTL.HISP. SA

Appendix 12

IRFs in Typical and Atypical Regimes for Greece

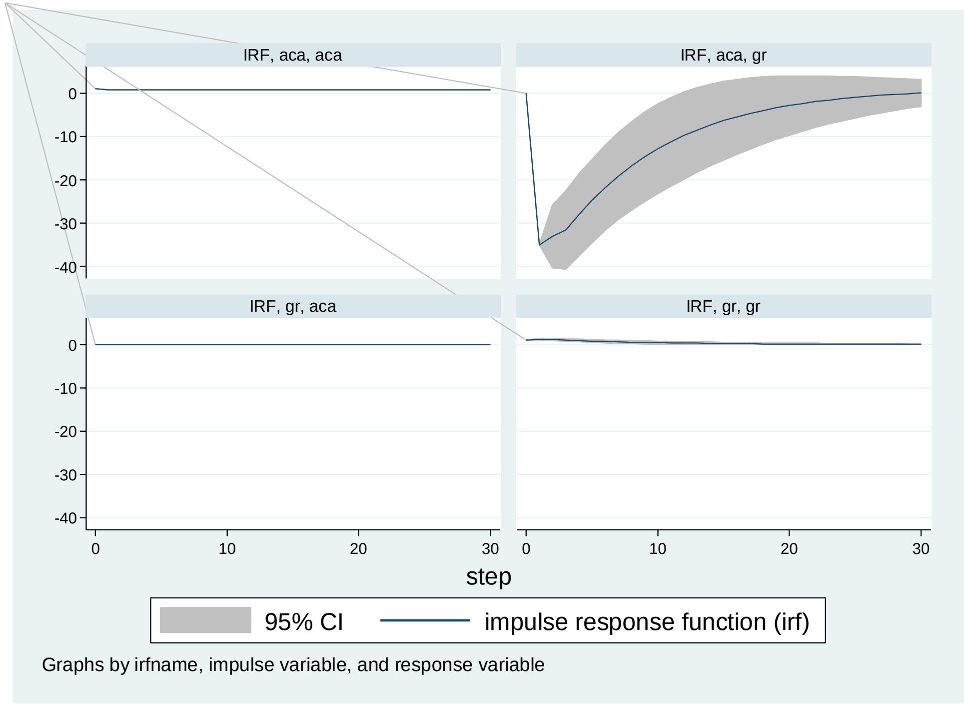
Typical Regime

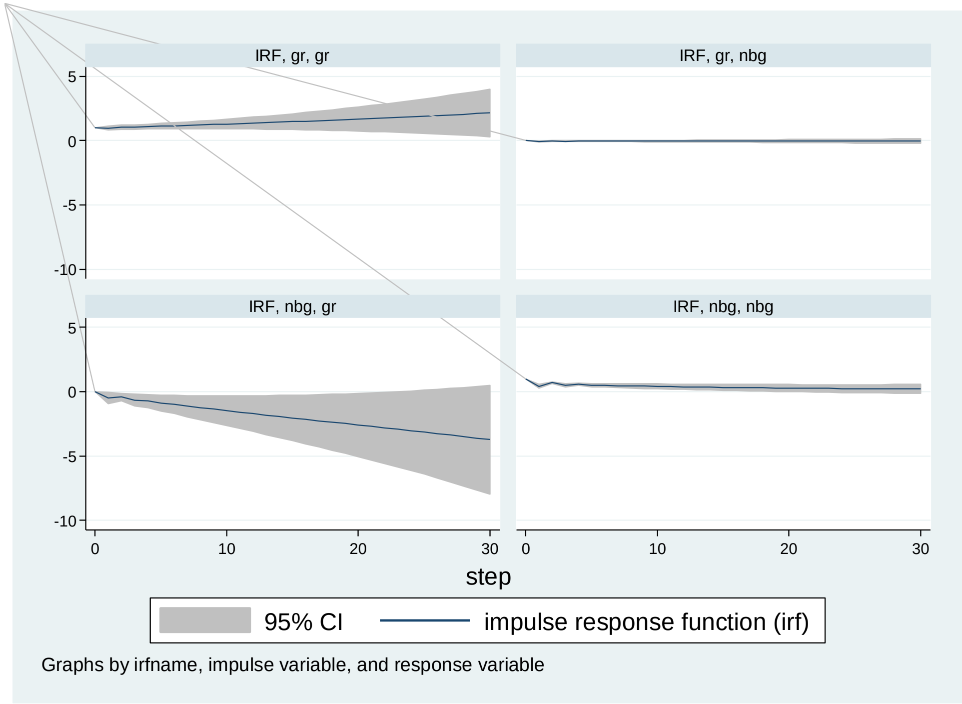




Appendix 12 *(continued)*

Atypical Regime

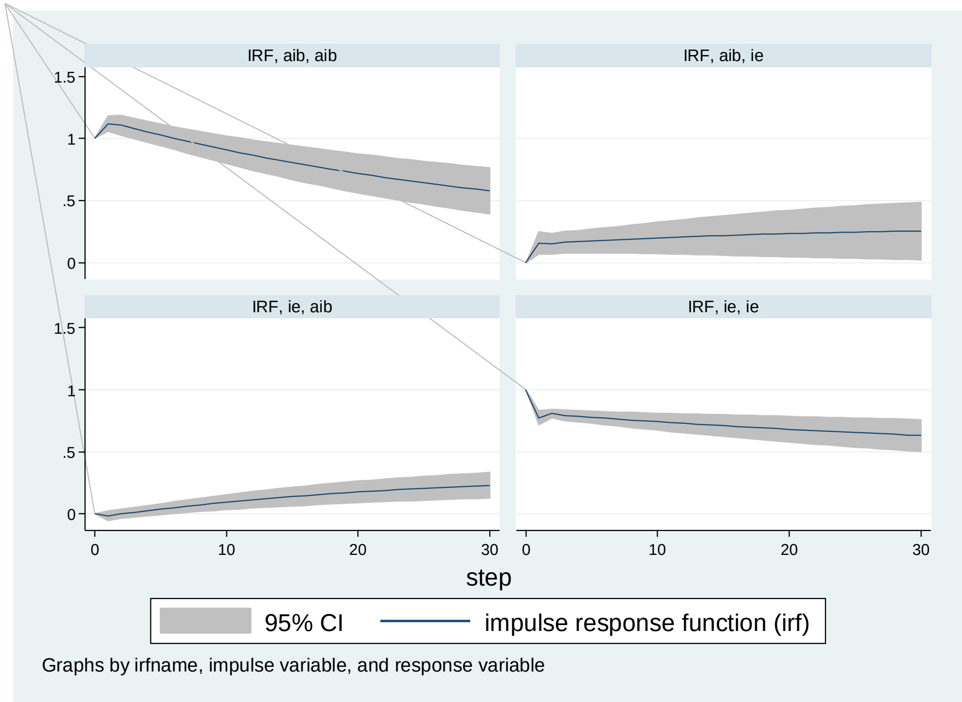


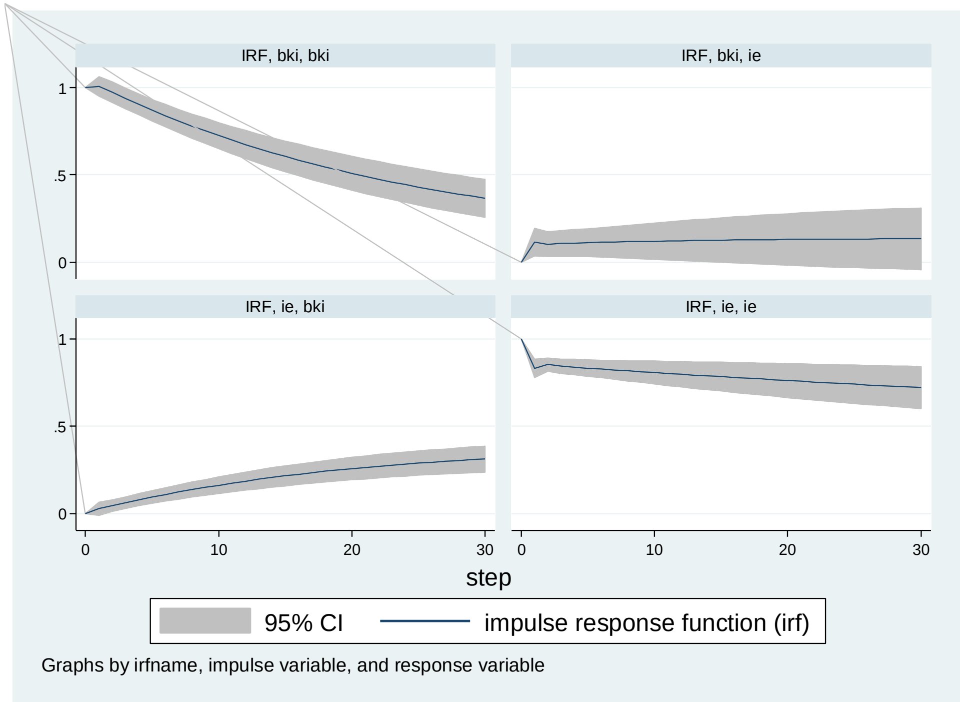


Appendix 13

IRFs in Typical and Atypical Regimes for Ireland

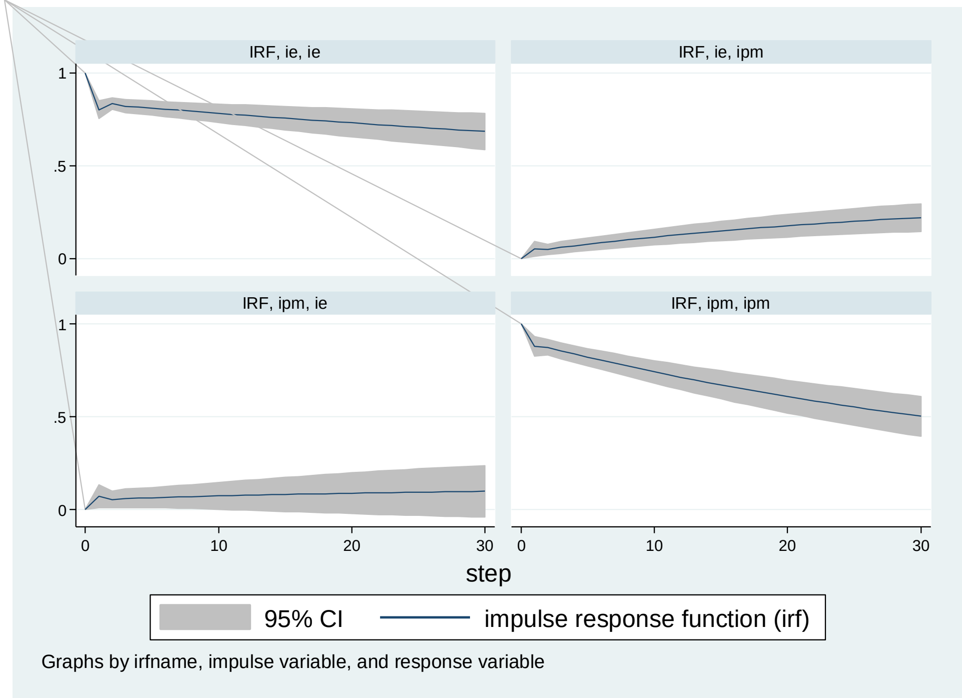
Typical Regime





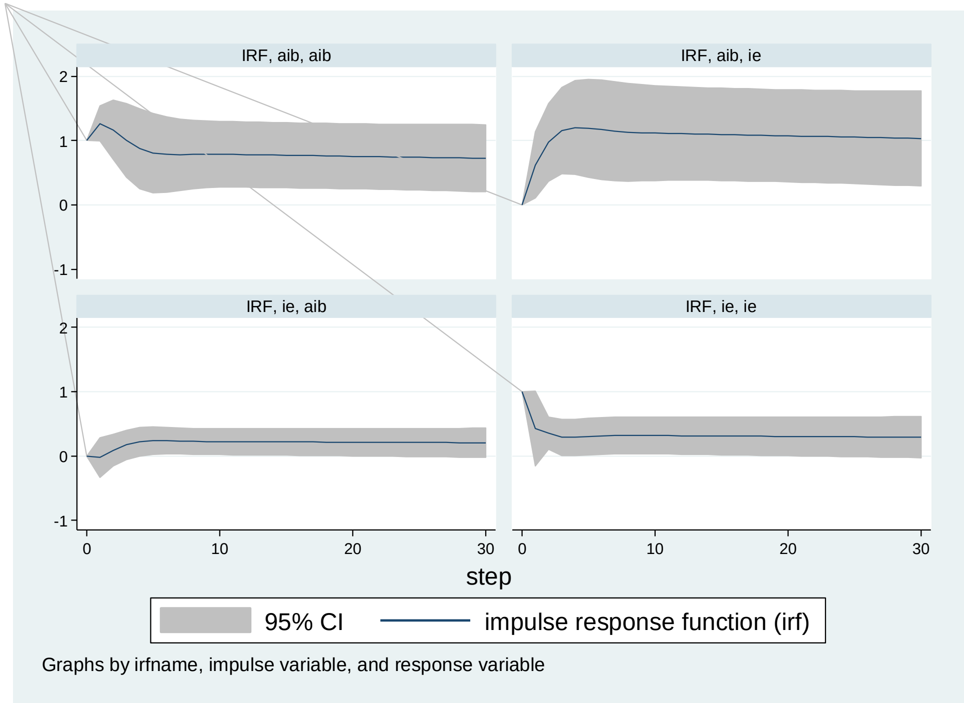
Appendix 13 *(continued)*

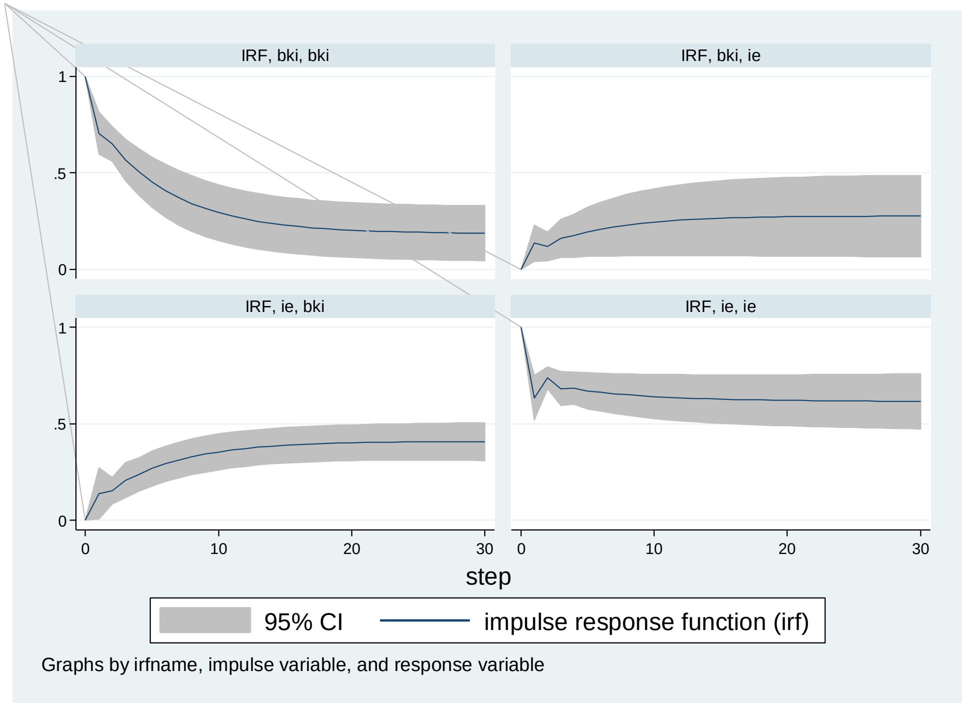
Typical Regime



Appendix 13 *(continued)*

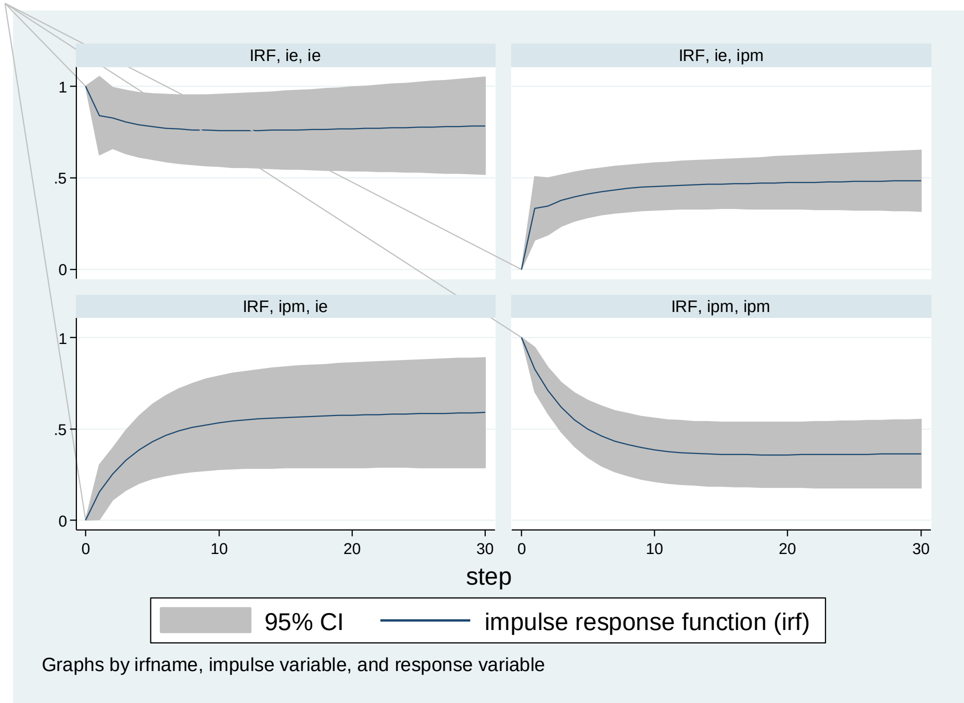
Atypical Regime



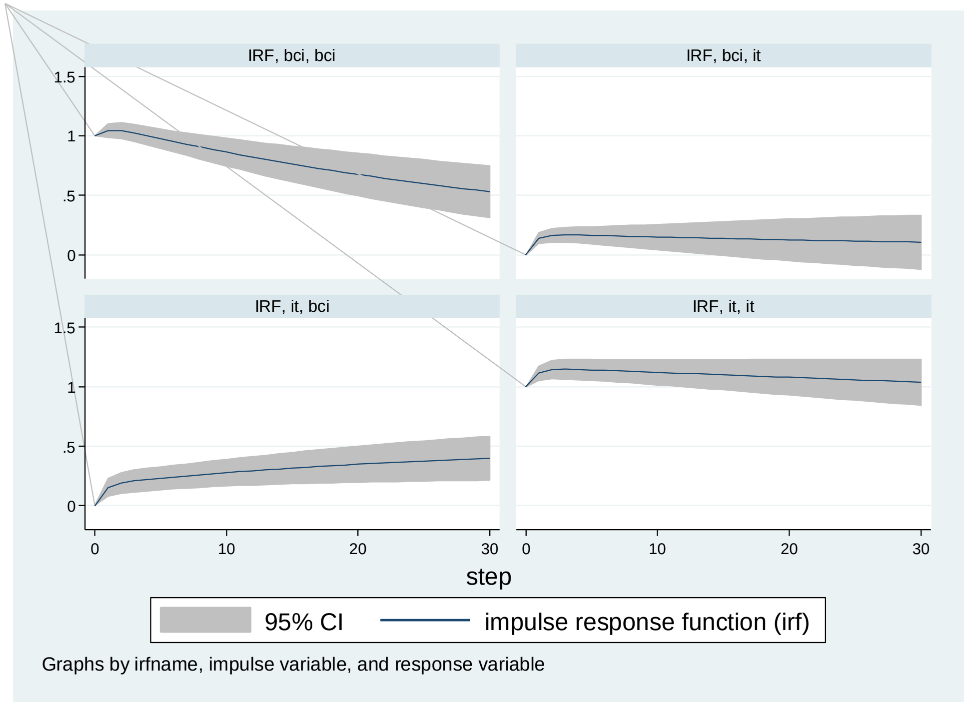


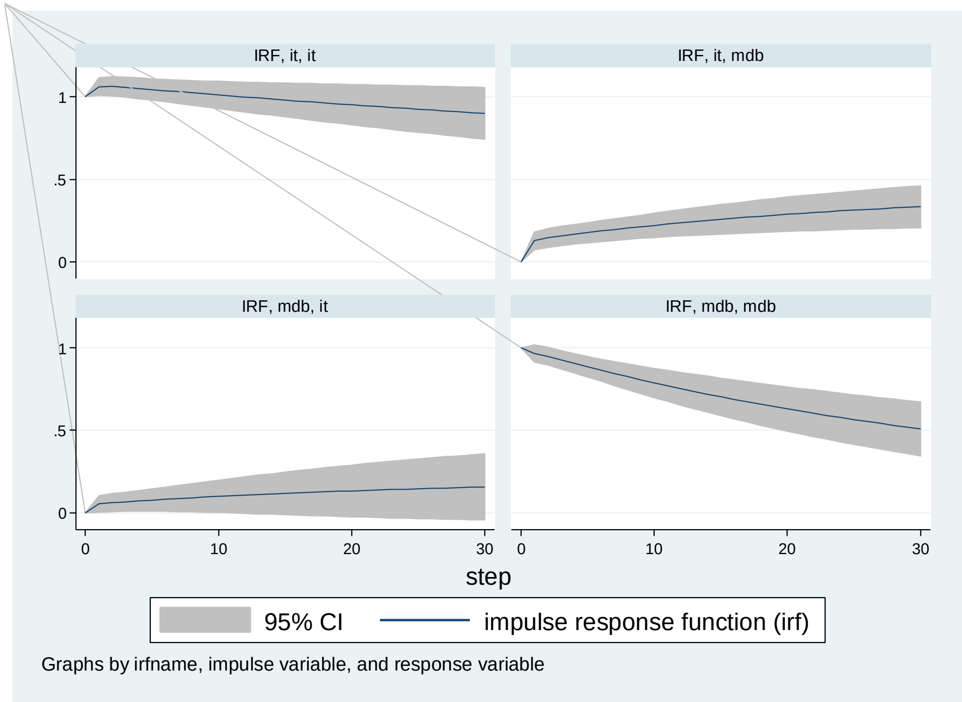
Appendix 13 *(continued)*

Atypical Regime



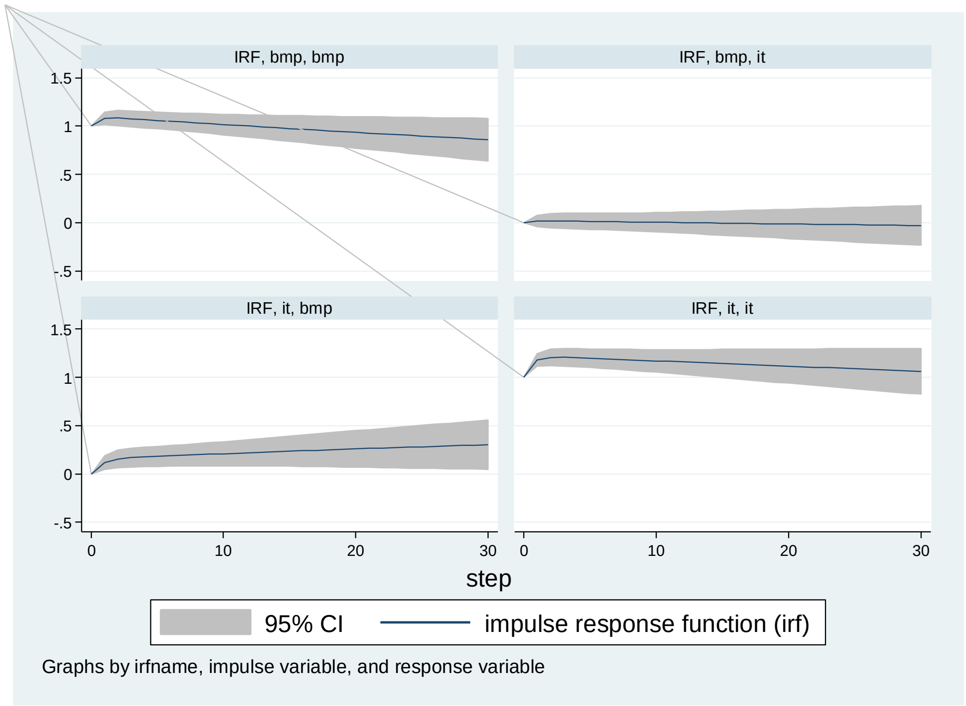
Appendix 14
IRFs in Typical and Atypical Regimes for Italy
Typical Regime

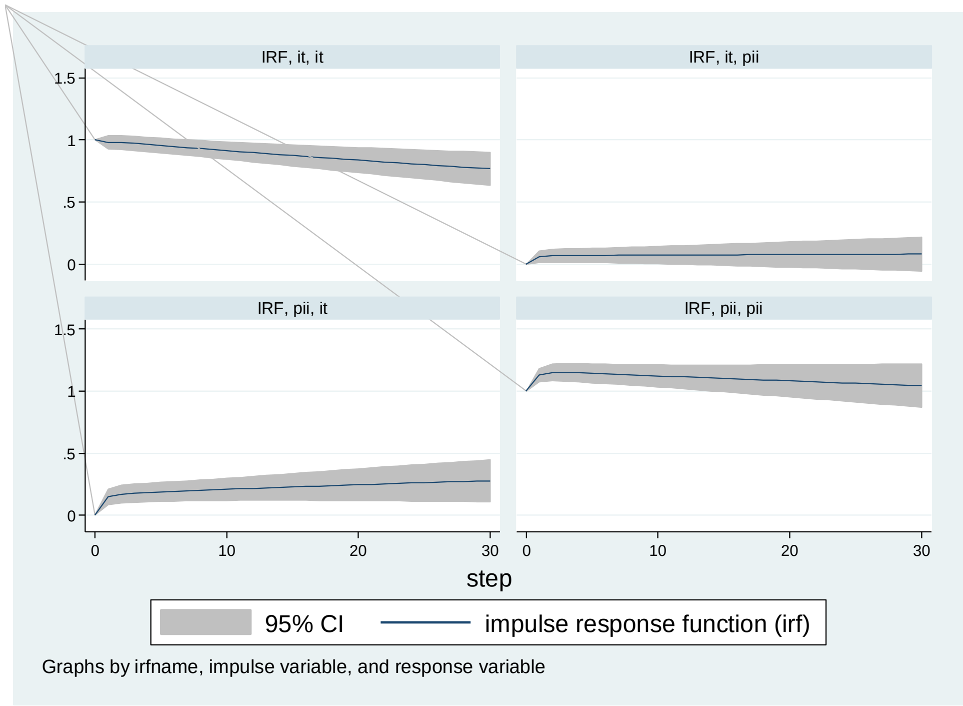




Appendix 14 *(continued)*

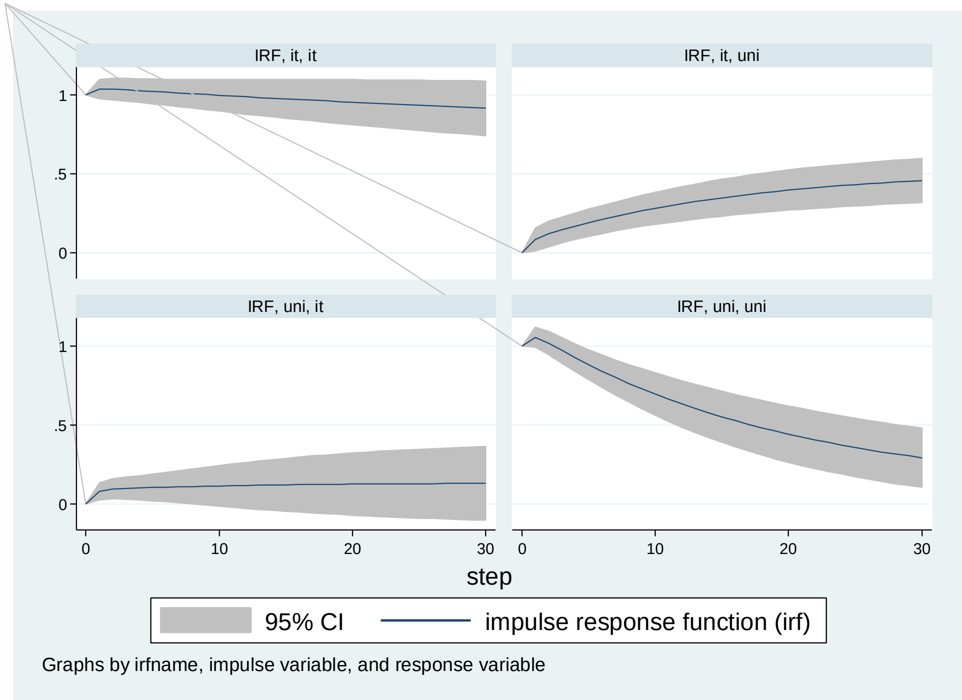
Typical Regime

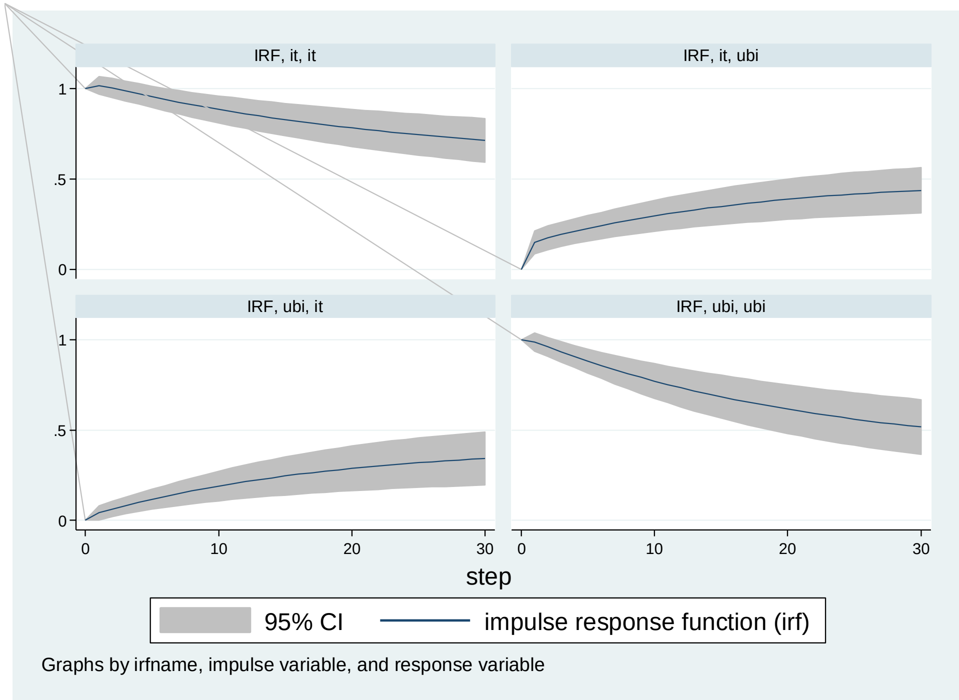




Appendix 14 *(continued)*

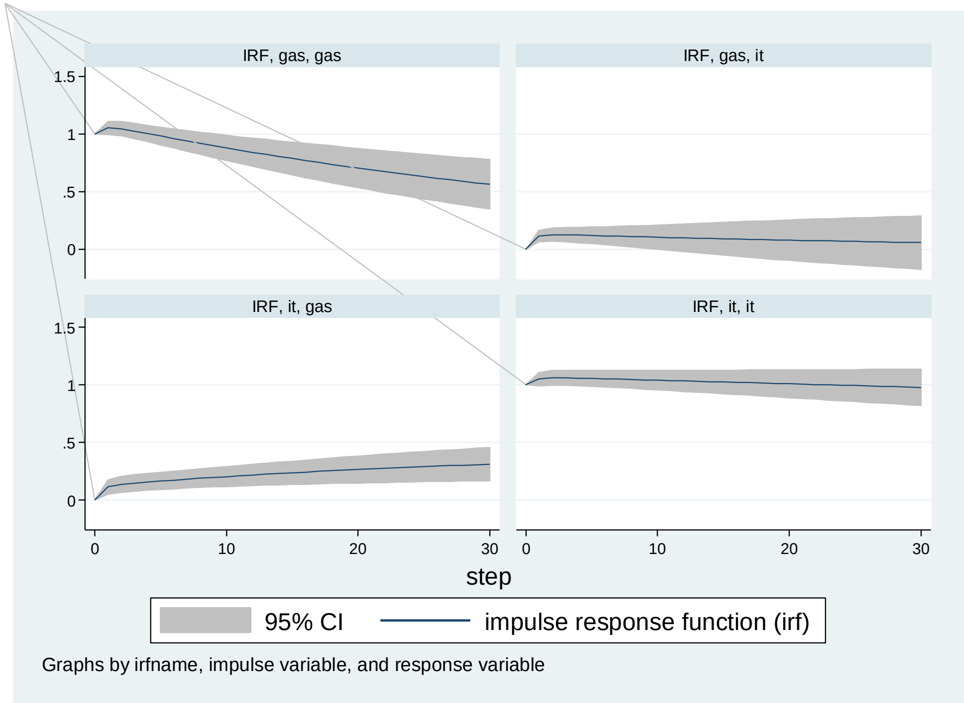
Typical Regime





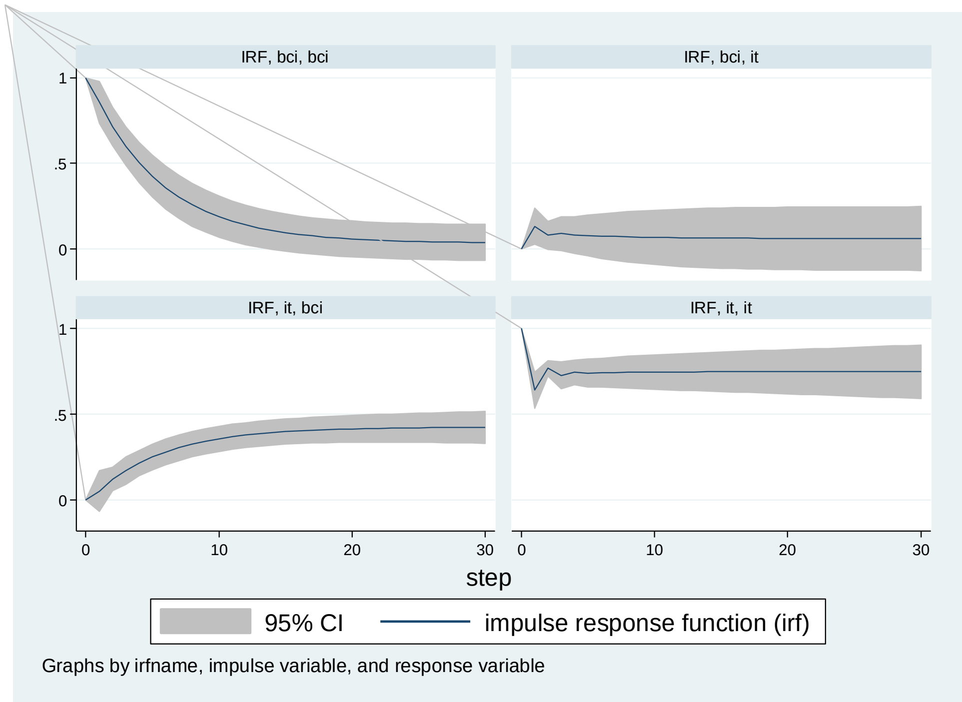
Appendix 14 *(continued)*

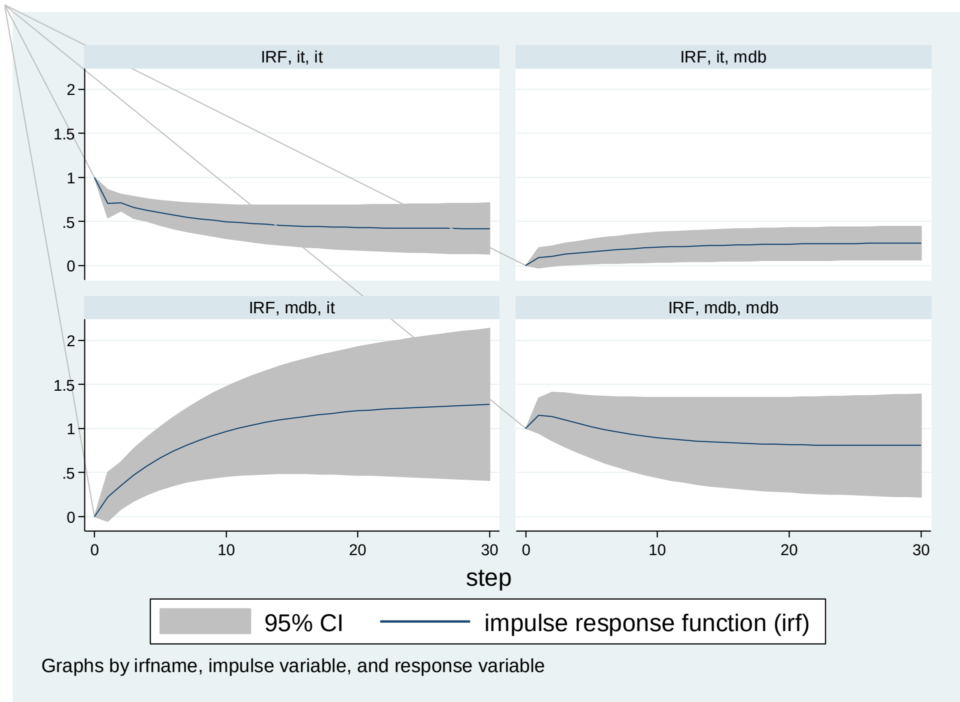
Typical Regime



Appendix 14 *(continued)*

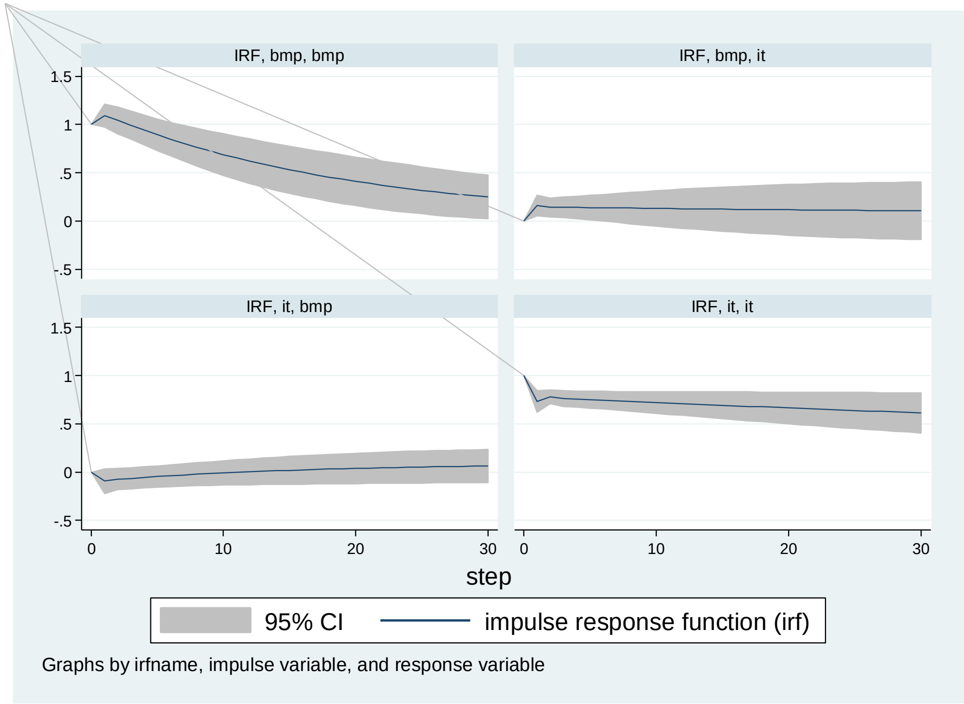
Atypical Regime

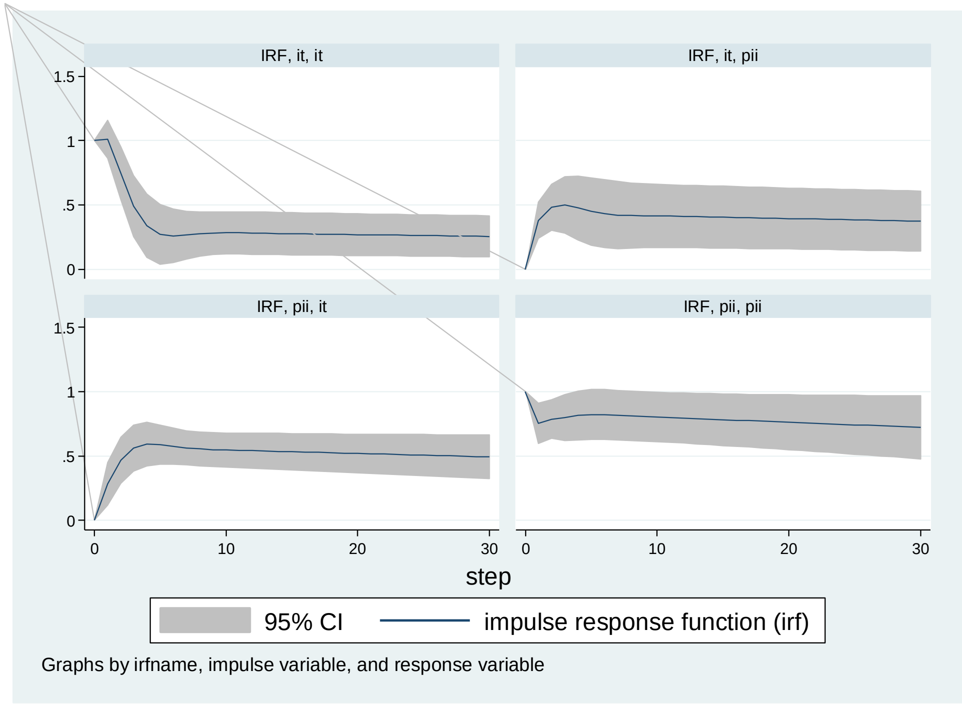




Appendix 14 *(continued)*

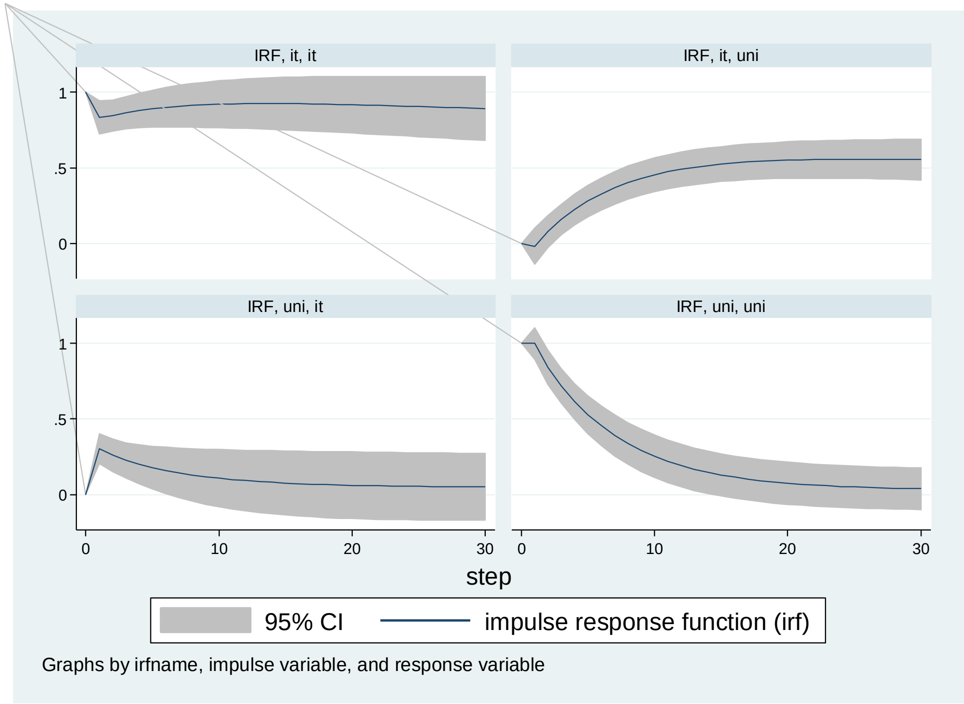
Atypical Regime

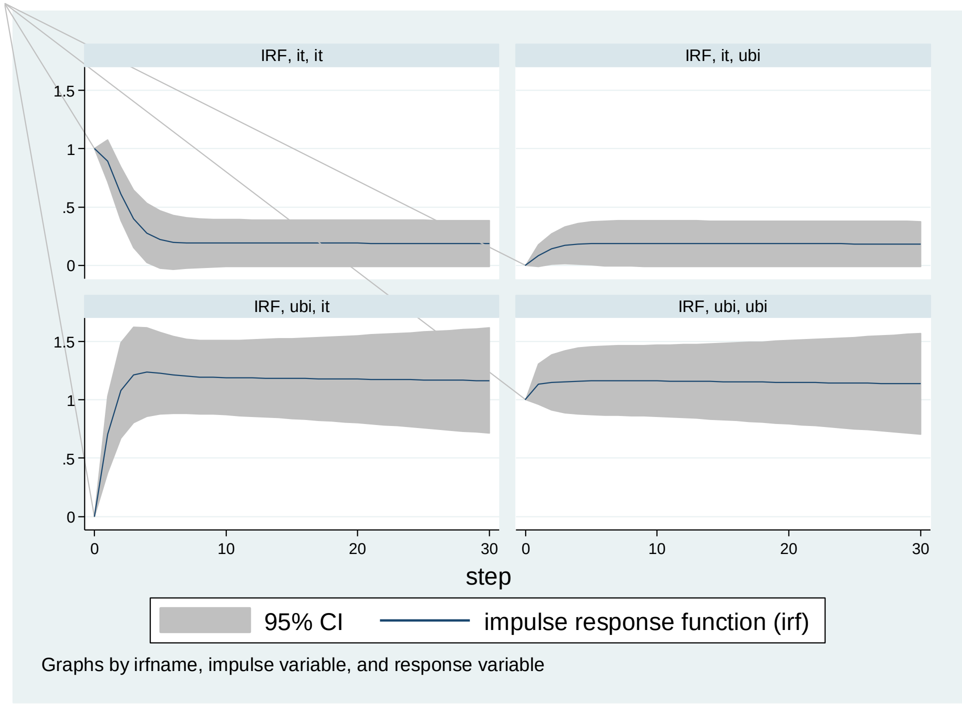




Appendix 14 *(continued)*

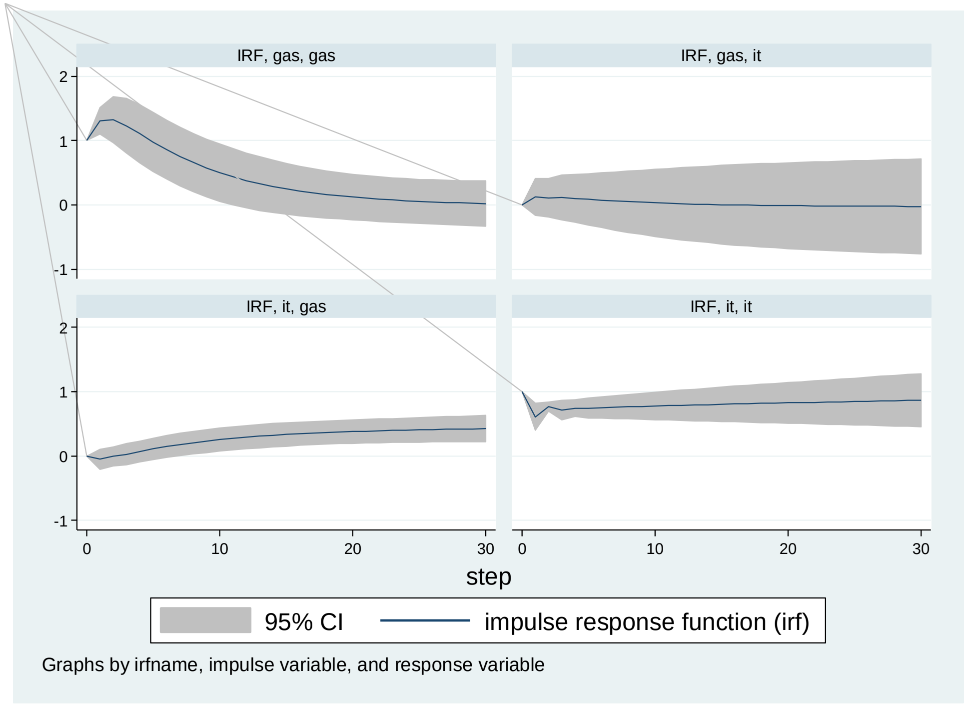
Atypical Regime





Appendix 14 *(continued)*

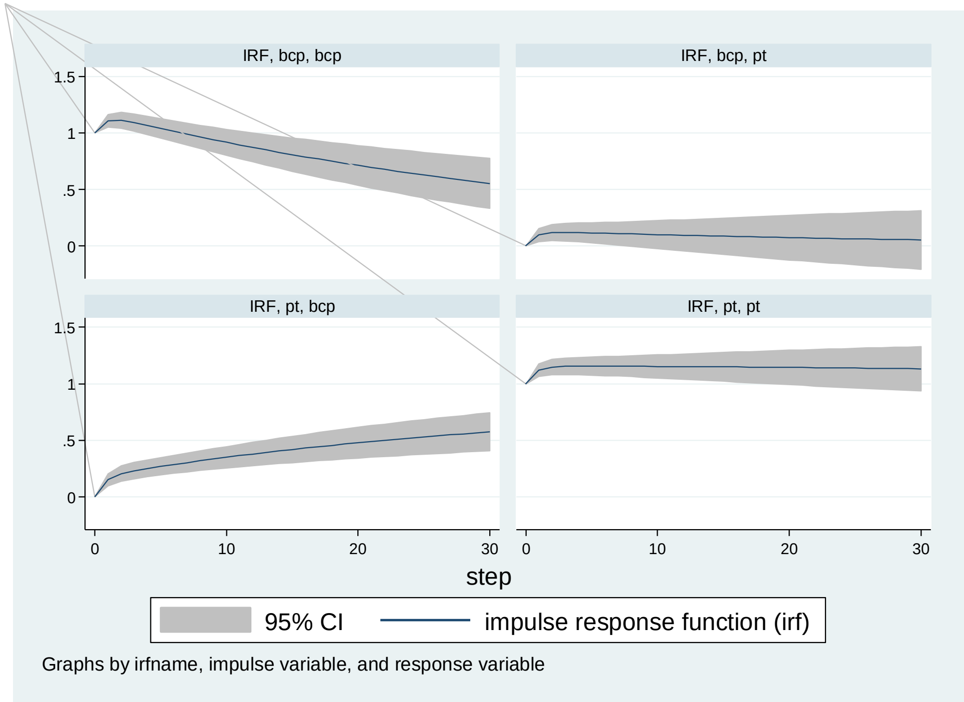
Atypical Regime

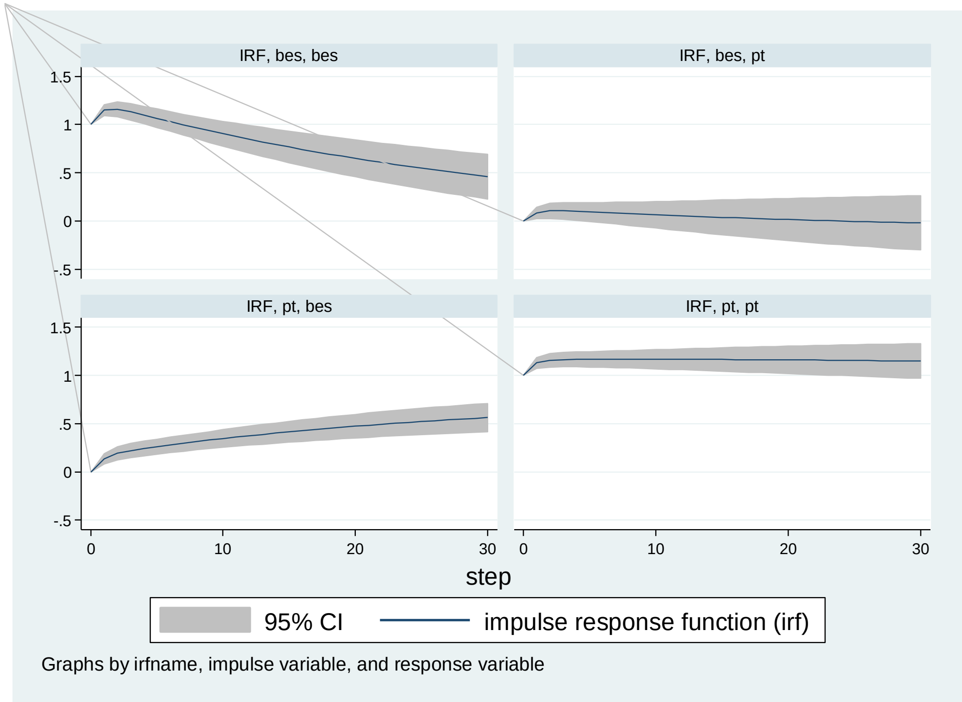


Appendix 15

IRFs in Typical and Atypical Regimes for Portugal

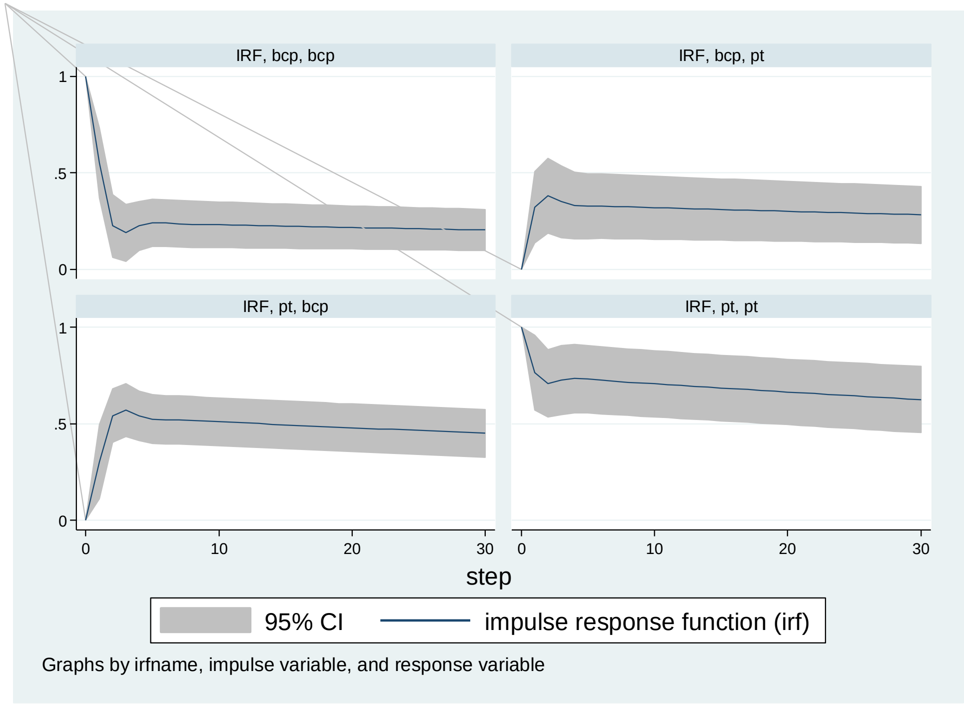
Typical Regime

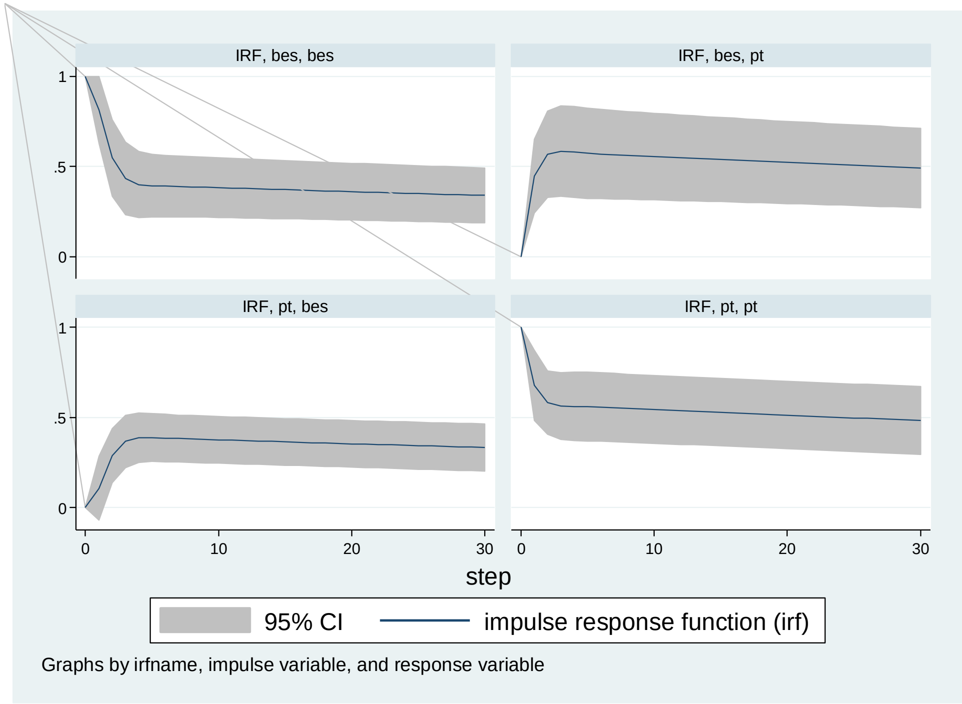




Appendix 15 *(continued)*

Atypical Regime

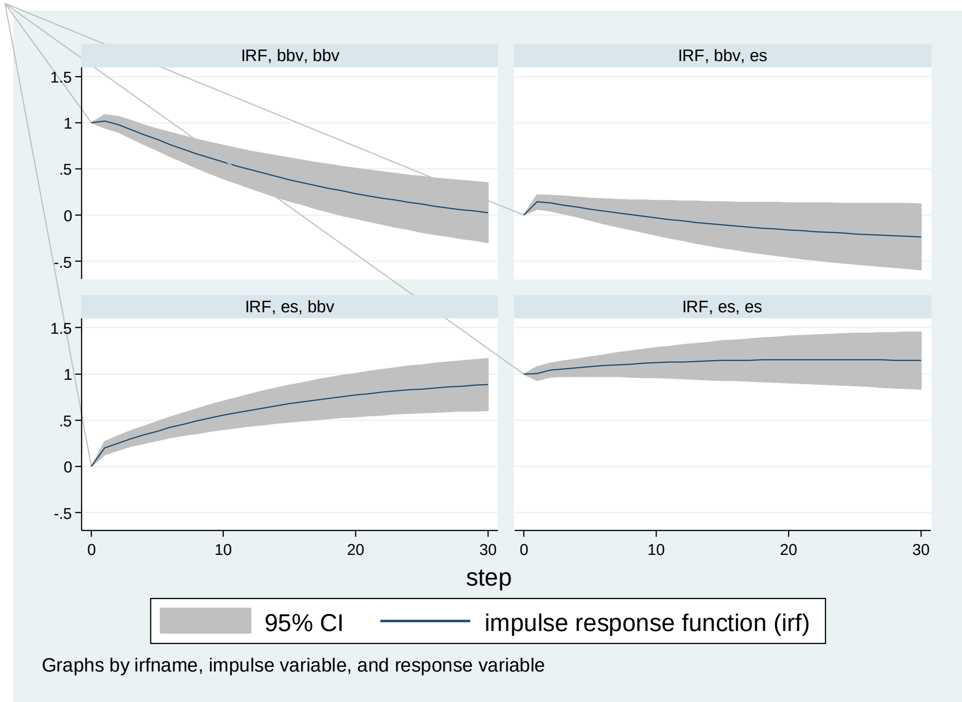


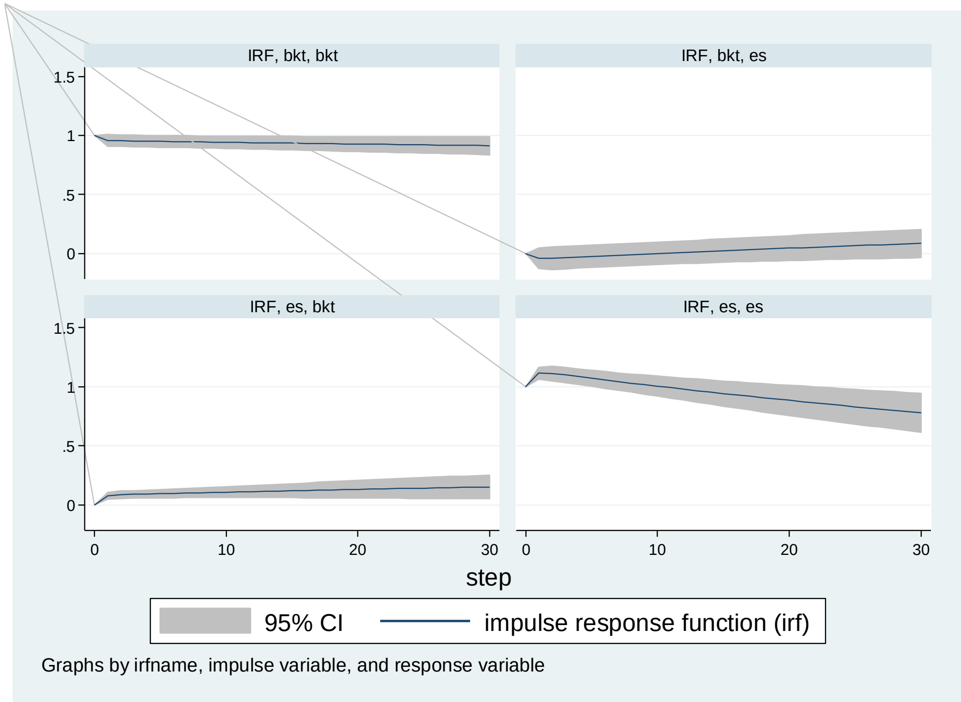


Appendix 16

IRFs in Typical and Atypical Regimes for Spain

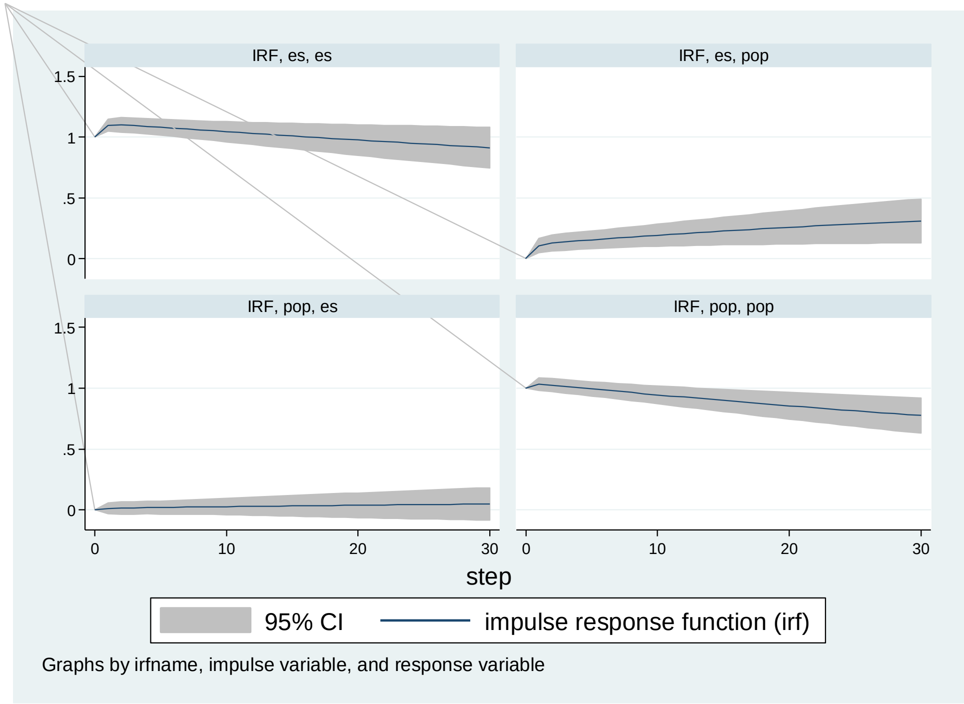
Typical Regime

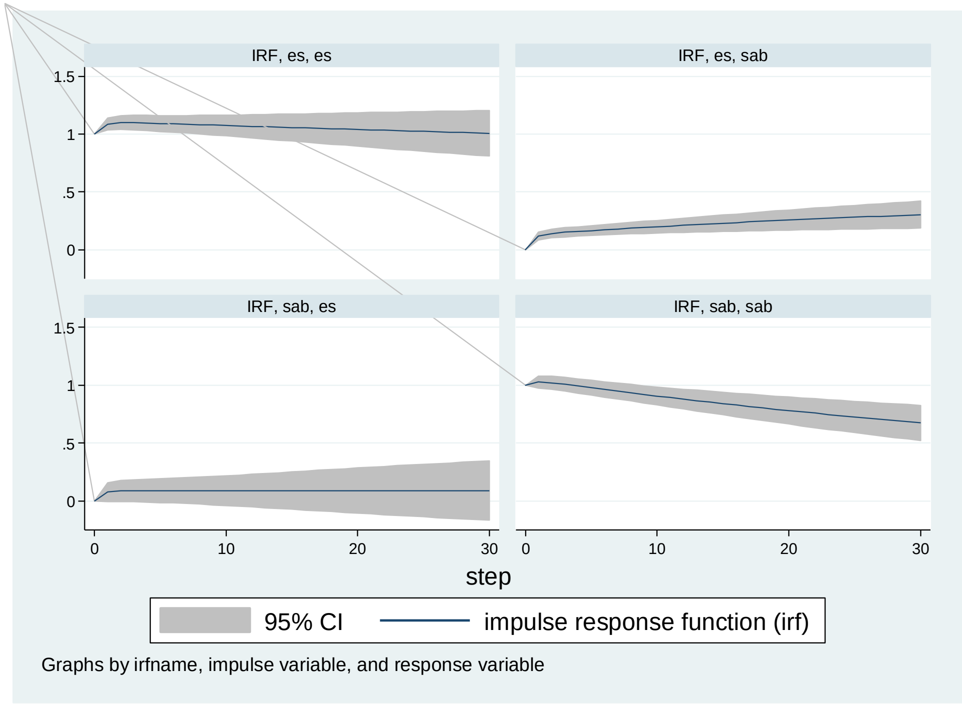




Appendix 16 *(continued)*

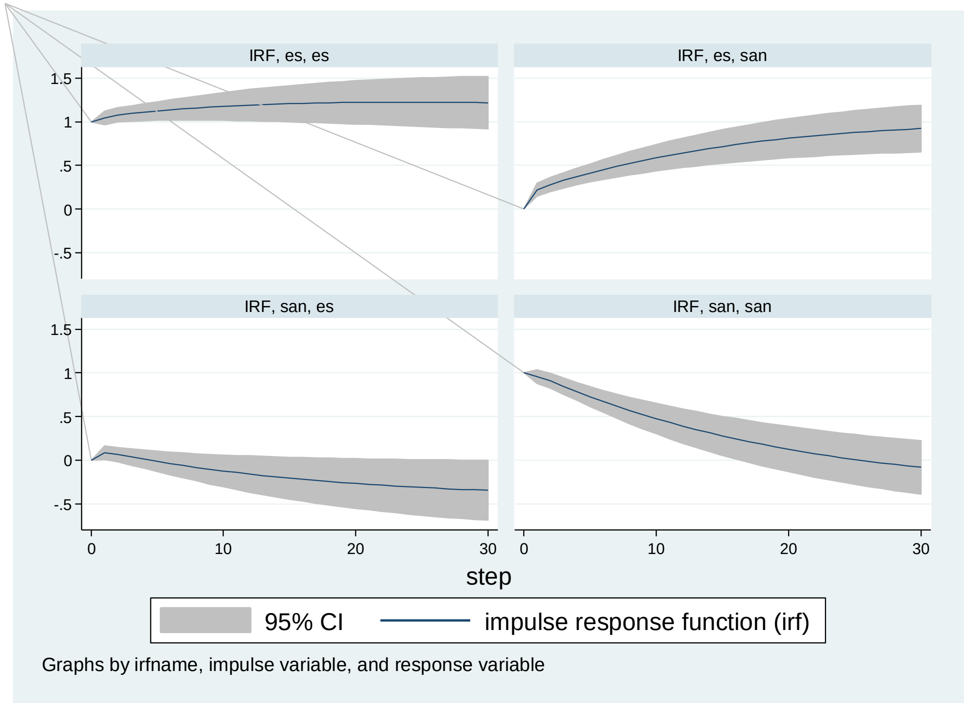
Typical Regime





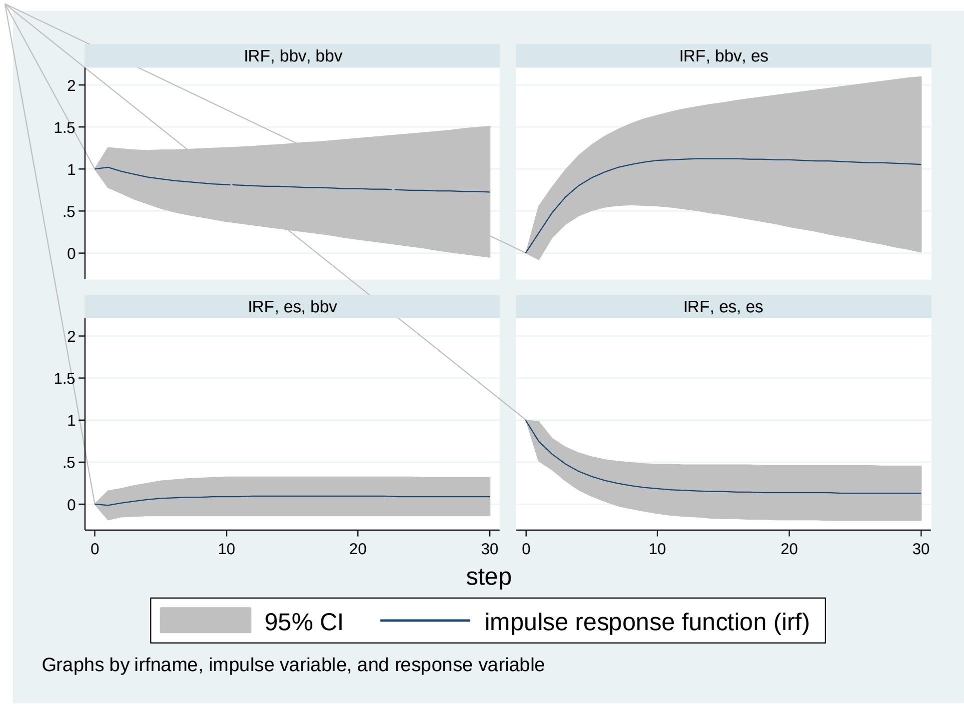
Appendix 16 *(continued)*

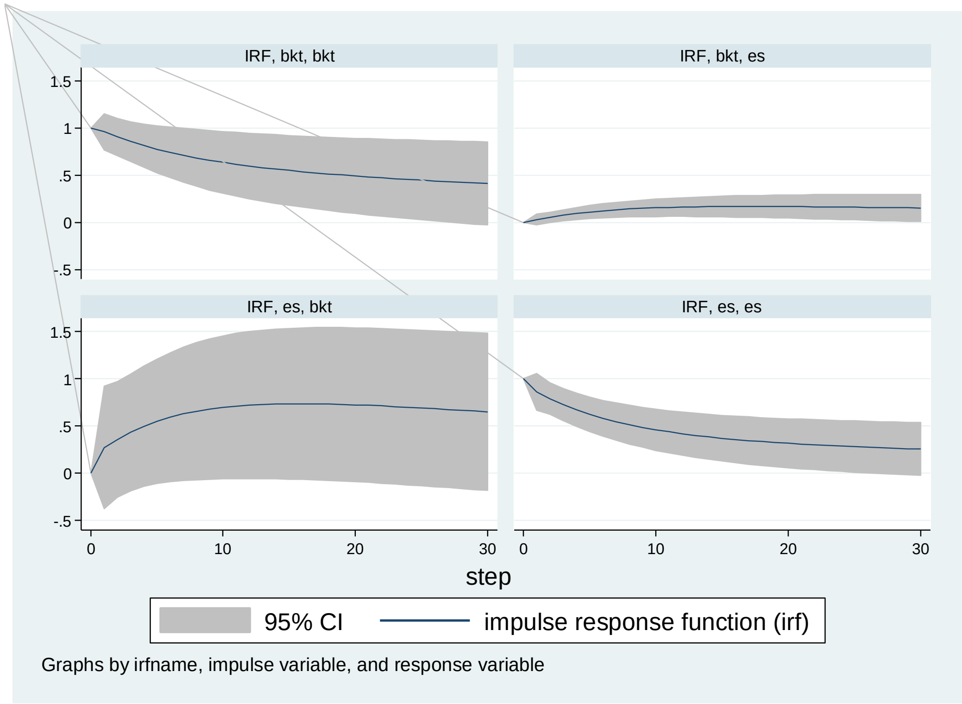
Typical Regime



Appendix 16 *(continued)*

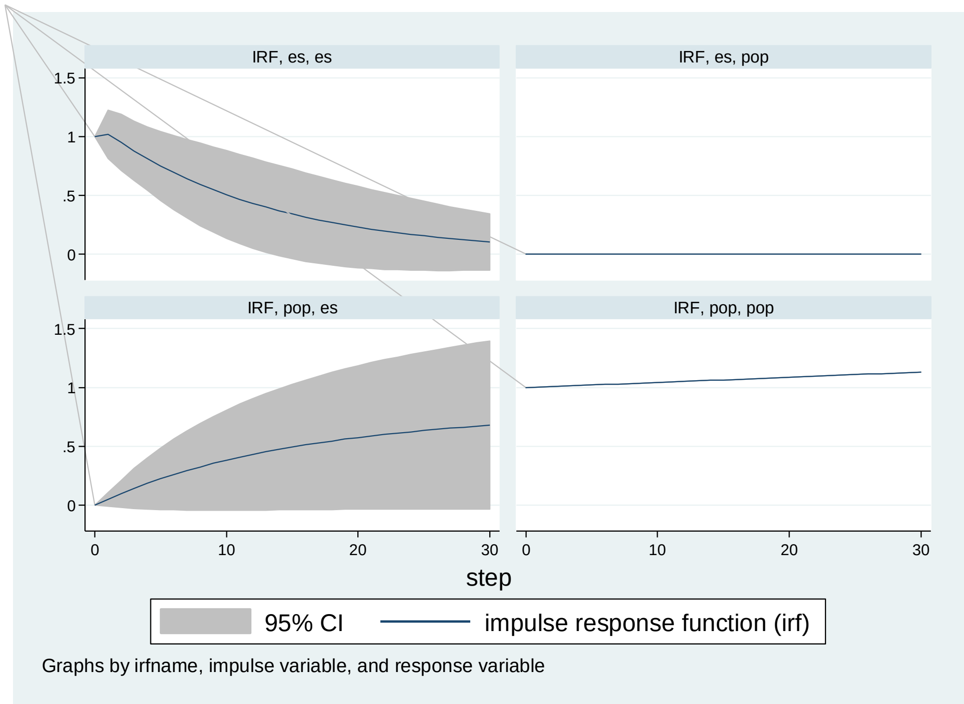
Atypical Regime

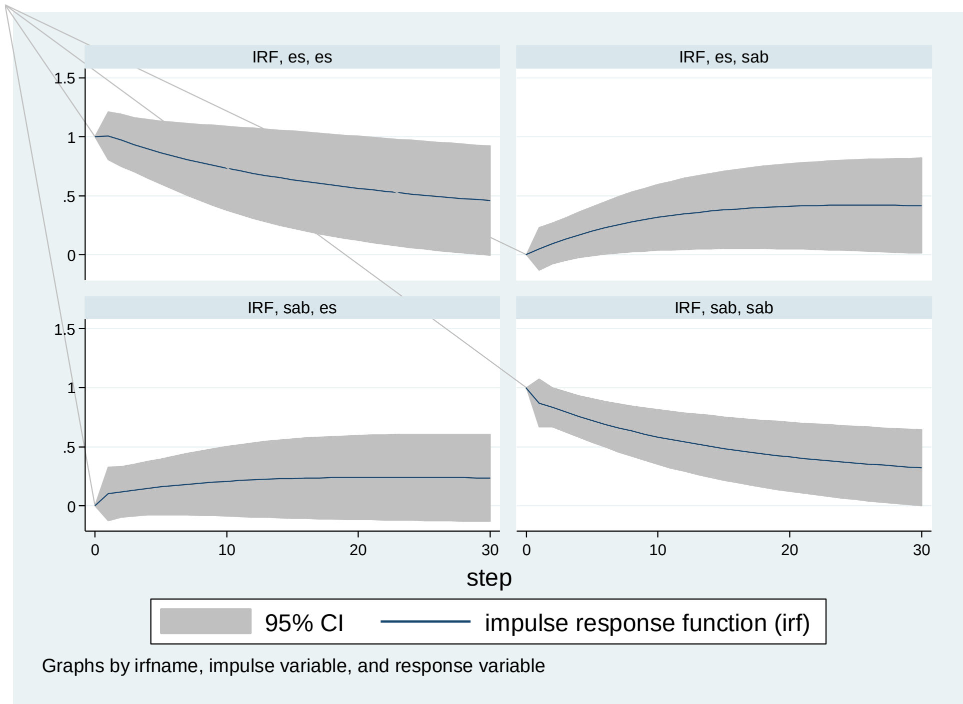




Appendix 16 *(continued)*

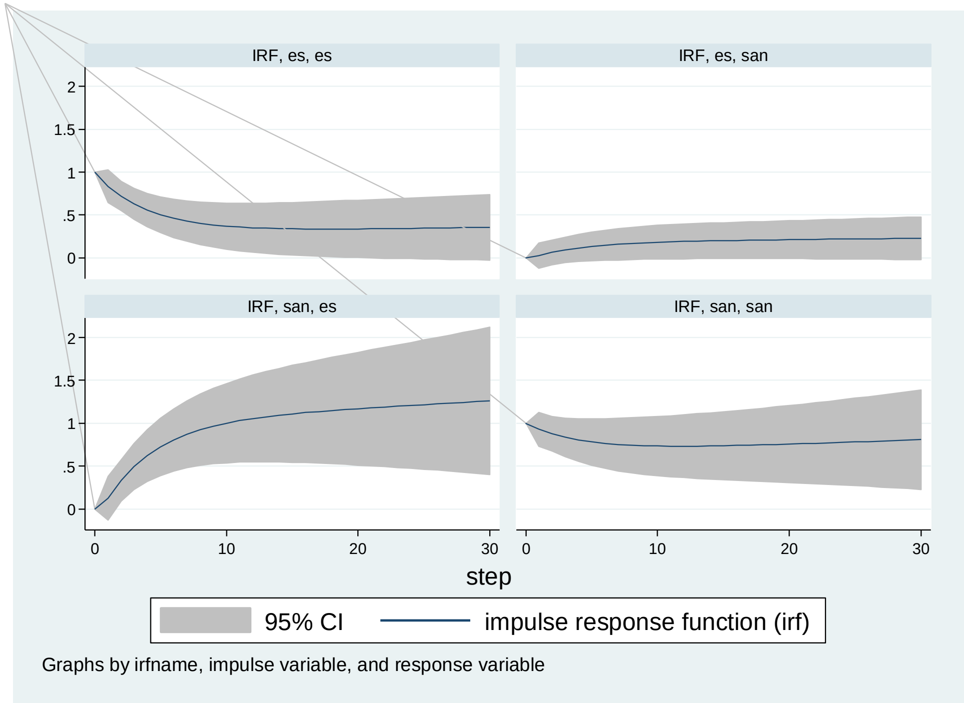
Atypical Regime





Appendix 16 *(continued)*

Atypical Regime



Appendix 17

The table lists the continuous series of call or put options of the ten European countries. The underlying indices of the call or put options are the stock indices in the countries.

Market	Option Name	Call/Put
Austria	Austrian Traded Index Continuous Call	Call
	Austrian Traded Index Continuous Put	Put
Belgium	Bel 20 Index (10) Continuous Call	Call
	Bel 20 Index (10) Continuous Put	Put
Denmark	OMX Copenhagen 20 Index Continuous Call	Call
	OMX Copenhagen 20 Index Continuous Put	Put
France	CAC 40 Index (10 Euro) Continuous Call	Call
	CAC 40 Index (10 Euro) Continuous Put	Put
Germany	DAX Index Continuous Call	Call
	DAX Index Continuous Put	Put
Italy	FTSE MIB Index Continuous Call	Call
	FTSE MIB Index Continuous Put	Put
Netherlands	AEX Index Continuous Call	Call
	AEX Index Continuous Put	Put
Spain	IBEX 35 Mini Index Futures Continuous Call	Call
	IBEX 35 Mini Index Futures Continuous Put	Put
Sweden	OMX Stockholm 30 Index Continuous Call	Call
	OMX Stockholm 30 Index Continuous Put	Put
United Kingdom	FTSE 100 Index (European) Continuous Call	Call
	FTSE 100 Index (European) Continuous Put	Put

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